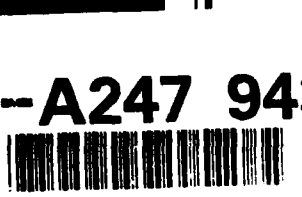
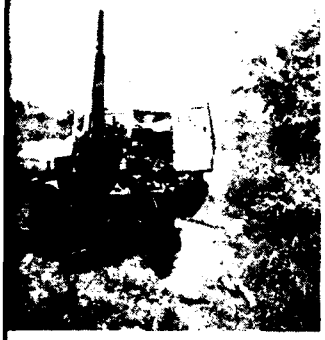
AD-A247 943



US Army Corps
of Engineers



TECHNICAL REPORT GL-90-2

LAND LOSS RATES

REPORT 3

LOUISIANA COASTAL PLAIN

by

J. B. Dunbar

Geotechnical Laboratory

DEPARTMENT OF THE ARMY
Waterways Experiment Station, Corps of Engineers
3909 Halls Ferry Road, Vicksburg, Mississippi 39180-6199

and

L. D. Britsch and E. B. Kemp III

US Army Engineer District, New Orleans
PO Box 60267, New Orleans, Louisiana 70160-0267

DTIC
ELECTE
MAR 24 1992
S B D

March 1992

Report 3 of a Series

Approved For Public Release: Distribution Is Unlimited

92-07462

Prepared for US Army Engineer District, New Orleans
New Orleans, Louisiana 70160-0267

92 025

Destroy this report when no longer needed. Do not return it to the originator.

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

The contents of this report are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official endorsement or approval of the use of such commercial products.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	March 1992	Report 3 of a Series

4. TITLE AND SUBTITLE
Land Loss Rates; Report 3, Louisiana Coastal Plain

5. FUNDING NUMBERS
DA Form 2544
No. CELMN-ED-91-20

6. AUTHOR(S)
J. B. Dunbar, L. D. Britsch, and E. B. Kemp III

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
See reverse.

8. PERFORMING ORGANIZATION REPORT NUMBER
Technical Report
GL-90-2

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
US Army Engineer District, New Orleans,
New Orleans, Louisiana 70160-0267

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
This report is available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

Land Loss mapping and rate curve development for 62 quadrangles in the Louisiana Coastal Plain shows that land loss rates and trends vary significantly throughout coastal Louisiana. Land loss rates for each quadrangle were defined for 4 time periods: 1930's to 1956-58, 1956-58 to 1974, 1974 to 1983, and 1983 to 1990. Differences in land loss rates among the individual quadrangles are a function of the geologic and hydrologic setting and the factors which contribute to land loss such as subsidence, storm induced erosion, channelization of streams and rivers, and canal dredging. Of the 62 quadrangles mapped, 9 quadrangles are losing more than 1 percent of their land area each year, and 12 quadrangles are losing between 0.5 and 1.0 percent per year during the 1983 to 1990 period.

On a regional scale, the land loss rate for the entire Louisiana Coastal Plain has decreased from an average yearly rate of 41.83 square miles in the 1956-58 to 1974 period to 25.34 square miles during the 1983 to 1990 period. The percentage of land being lost is also decreasing from 0.51 percent per year in the 1956-58 to 1974 period to 0.35 percent per year during the 1983 to 1990 period. The regional land loss rate will probably continue to decrease slowly until a background rate is reached.

14. SUBJECT TERMS
Coastal Louisiana
Land loss
Louisiana Chenier Plain
Mississippi River Deltaic Plain
Wetland loss
Wetlands

15. NUMBER OF PAGES
65

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED		

7. (Continued).

USAE Waterways Experiment Station, Geotechnical Laboratory
3909 Halls Ferry Road, Vicksburg, Mississippi 39180-6199

USAE District, New Orleans
PO Box 60267
New Orleans, Louisiana 70160-0267

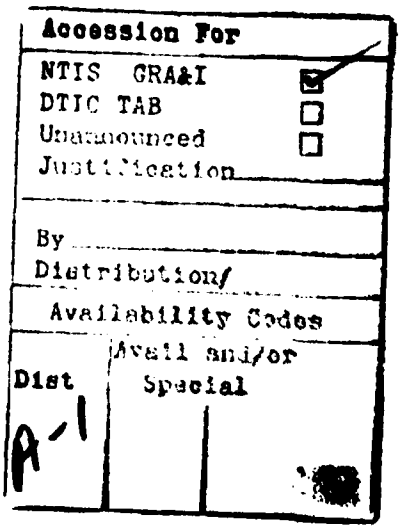
PREFACE

This investigation was authorized by the US Army Engineer District, New Orleans (CELMN), under the heading "Louisiana Coastal Plain, Land Loss Mapping: 1983-1989" by DA Form 2544, No. CELMN-ED-91-20, dated 8 November 1990 and amended 19 February 1991, 6 June 1991, 12 July 1991, and 16 August 1991.

This investigation was performed and the report prepared during the period 8 November 1990 to 31 January 1992. The Program Manager for this study was Mr. E. B. Kemp III, Chief, Geology Section, Engineering Division (ED-FG), CELMN. Land loss mapping and rate curve development were performed by Mr. J. B. Dunbar, Geologic Environments Analysis Section (GEAS), Engineering Geology Branch (EGB), Earthquake Engineering and Geosciences Division (EEGD), Geotechnical Laboratory (GL), Waterways Experiment Station (WES). This report was prepared by Messrs. J. B. Dunbar, WES; L. D. Britsch, CELMN; and E. B. Kemp III, CELMN.

This investigation was conducted under the direct supervision of Messrs. R. J. Larson, Chief, GEAS, and Joe Gatz, Chief, EGB, and under the general supervision of Drs. A. G. Franklin, Chief, EEGD, and W. F. Marcuson III, Chief, GL.

Dr. Robert W. Whalin was Director of WES. COL Leonard G. Hassell, EN, was Commander and Deputy Director of WES during the preparation of this report.



CONTENTS

	Page
PREFACE	1
PART I: INTRODUCTION	3
Background	3
Purposes and Scope	3
PART II: DATA SOURCES AND MAPPING PROCEDURES	5
Data Sources	5
Land Loss Interpretation and Classification	5
Land Loss Mapping and Area Measurement	7
PART III: LAND LOSS RATES	8
Land Loss Rates of Individual Quadrangles	8
1930's Base Land and Water Data	17
Composite Land Loss Rates	23
PART IV: CONCLUSIONS	27
REFERENCES	28
APPENDIX A: LAND LOSS RATE CURVES	A1
APPENDIX B: PERCENT LAND LOSS RATE CURVES	B1

LAND LOSS RATES: LOUISIANA COASTAL PLAIN

PART I: INTRODUCTION

Background

1. This study is the third in a series by the US Army Engineer District, New Orleans (CELMN), and the US Army Engineer Waterways Experiment Station (WES) on land loss rates in coastal Louisiana. Earlier studies by Britsch and Kemp (1990) and Dunbar, Britsch, and Kemp (1990) defined land loss rates and presented land loss rate curves for individual US Geological Survey (USGS) 15-minute (min) quadrangles in the Mississippi River Deltaic and Chenier Plains, respectively (see Figure 1). Together, these two geomorphic regions form an area consisting of 62 USGS 15-min quadrangles, an area of approximately 18,000 square miles.* In both studies, land loss rates for three time periods (1930's to 1956-58, 1956-58 to 1974, and 1974 to 1983) were identified for each quadrangle. This study is a continuation of these earlier studies and presents the most recent land loss rate and trend data for the 1983 to 1990 time period.

Purposes and Scope

2. The purposes for this study are to document on maps the location of the land loss and determine the magnitude of the loss that has occurred in coastal Louisiana between the 1930's and 1990. Specific objectives of this study are to: (a) map the land loss that has occurred for the 1983 to 1990 time period for each 15-min (1:62,500 scale) USGS quadrangle in the study area, (b) determine land loss rates for each quadrangle mapped and for the entire Louisiana coastal plain, and (c) identify significant historic land loss trends. Data from this study are being used by CELMN to assist planning studies and wetland restoration projects. This report will not evaluate site-specific causes for land loss in coastal Louisiana but will address generic causes for the land loss.

---

* Multiply square miles by 2.589998 to obtain square kilometres.

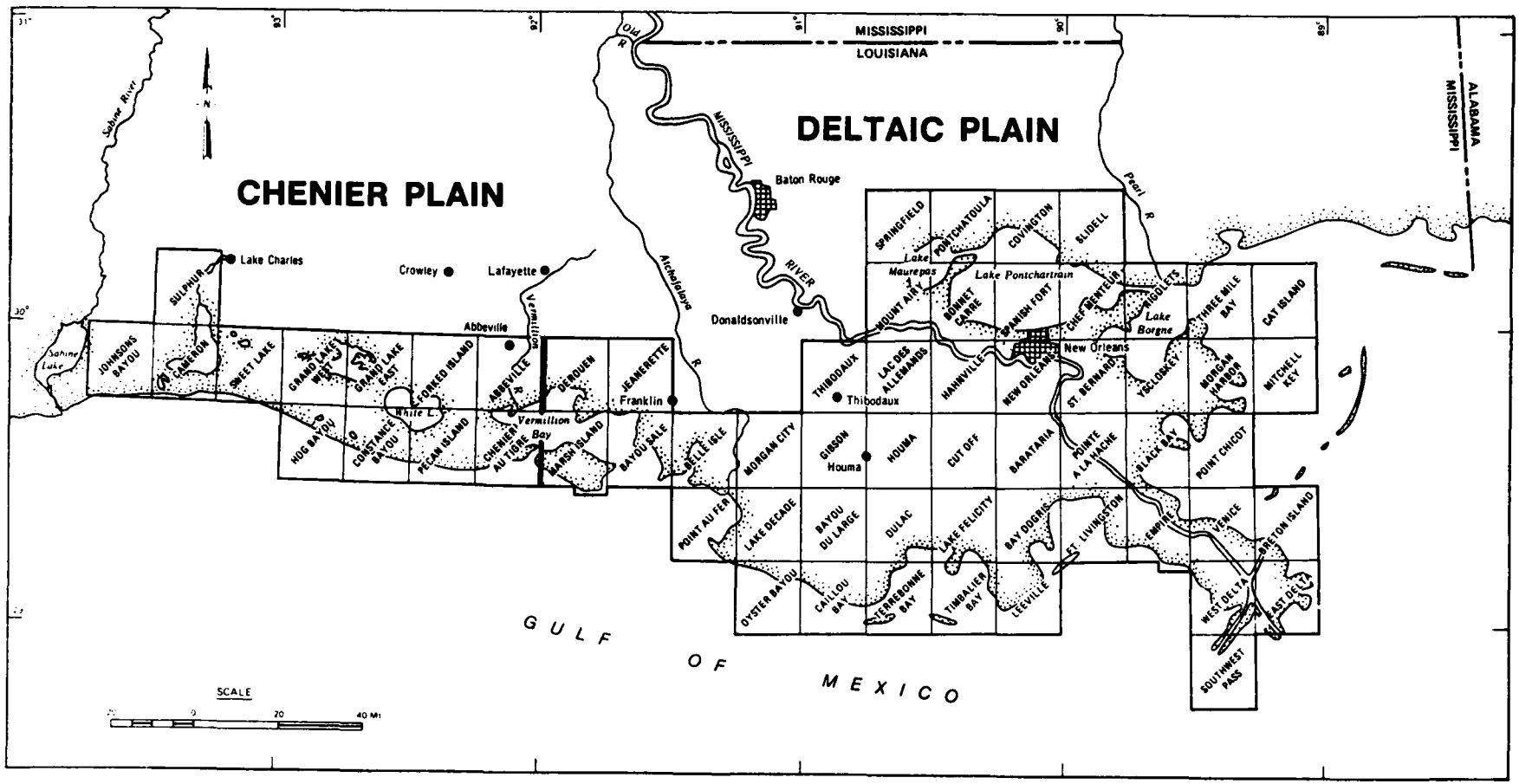


Figure 1. Index map to the study area showing 15-min quadrangles in the Louisiana Coastal Plain

PART II: DATA SOURCES AND MAPPING PROCEDURES

Data Sources

3. Land loss mapping was accomplished by comparing four vintages of aerial photography with a base map and delineating the land loss that occurred over the period of record on the base map. Sources of map and photographic data used in this study are identified in Table 1. For the 1990 land loss update, WES and CELMN engaged NASA to fly a special high altitude photographic mission (ER-2 flight, December 8-9, 1990) over coastal Louisiana. Land loss mapping was conducted from the photography (scale: 1:62,500) obtained during the NASA overflight.

4. In addition to the photography, 12-channel Thematic Mapper Simulated (TMS) digital data (approximately 24-m resolution) of the study area was used as an aid in the land loss mapping for interpretation of problem areas. Land loss mapping was based on the photography rather than the digital data since previous mapping was photography based.

5. The base maps used were either US Coast and Geodetic Survey Air Photo Compilation Sheets (T-sheets) or early USGS 15-min topographic quadrangle maps. Both types of base maps are based on interpretation of early aerial photography. T-sheets were the preferred base map for this study as they are the earliest and most comprehensive base map available for Louisiana's coastal plain. T-sheets were photographically reduced to a USGS 15-min (1:62,500) quadrangle map format for mapping. For those areas where T-sheet coverage was not available, the earliest available USGS 15-min topographic quadrangle map was used for the base map. Both T-sheets and early 15-min USGS quadrangle maps were photographically transferred onto stable transparent film to produce the mapping base.

Land Loss Interpretation and Classification

6. This study documents changes from land to water over a period of approximately 60 years. Land loss is considered to be any land area present on either the base maps or 1930's photography that was interpreted as water on later photographic coverages. Land loss identified during the mapping

Table 1
Sources of Map and Photographic Data

Date	Source	Original Scale
1932-33	US Coast and Geodetic Survey Air Photo Compilation Sheets (T-sheets)	1:20,000
1933-55	USGS 15-Minute Topographic Quadrangle Maps	1:62,500
1933-35	Tobin Surveys, Black-And-White Aerial Photo Mosaics	1:62,500
1956-58	Tobin Surveys, Black-And-White, Aerial Photo Mosaics	1:24,000
1974	NASA Color IR	1:120,000
1983	National High Altitude Program, Color IR	1:58,000
1990	NASA Color IR	1:62,500

includes both loss from man-made causes as well as loss due to natural processes. Most of the land loss classified as man-made is the direct result of dredging for various types of canals and waterways. All land loss not the direct result of man's activities was considered natural loss.

7. Because the distinction between land and water is so critical to the accuracy of this study, it is important to identify the criteria used to distinguish between land and water. Water was classified as any area of water having no permanent vegetation visible at the surface. Permanent vegetation, for purposes of this investigation, is that which is attached to the substrate, not floating vegetation such as hydrilla and hyacinths. Land was simply defined as everything on the photography (or base map) not classified as water. Generally, the only land areas on the photography without some visible vegetation were beaches and dredged sediments.

Land Loss Mapping and Area Measurement

8. A detailed discussion of the land loss mapping process is omitted from this report as it was described in detail by Britsch and Kemp (1990). In summary, land loss mapping during this study consisted of comparing the land areas on the base maps (transparent film positive of 15-min USGS quadrangle map) to land areas on the photography and delineating areas of land loss on the overlay base map. Land loss areas were defined for each photographic period examined. The resulting land loss map identified the overall land loss that had occurred during the four time periods mapped (1930's to 1956-58; 1956-58 to 1974; 1974 to 1983; and 1983 to 1990) and whether it was man-made (i.e., dredged canals) or natural loss.

9. Land loss areas were determined by optical scanning (digitizing) of individual overlays prepared for each map. Black ink overlays were prepared for each map for both the natural and man-made land loss identified for each period. The amount of land loss during each period was calculated for each map by optically scanning the ink overlays and computer processing the scanned (digitized) data. Land loss rates were determined for each period and a rate curve was constructed for each quadrangle. Examples of the different steps involved in land loss mapping and additional information about the mapping procedure are described in more detail by Britsch and Kemp (1990).

PART III: LAND LOSS RATES

Land Loss Rates for Individual Quadrangles

Land Loss Rates in Square Miles Per Year

10. Land loss rates in square miles per year for the 62 USGS quadrangle maps in the Louisiana Coastal Plain are identified in Table 2. Rate curves for these quadrangles are presented in Appendix A. Time periods for which the land loss rates are based are shown in Table 2 and graphically by horizontal bars on the land loss rate curves in Appendix A. A summary of land loss rates for the different time periods mapped is presented in Figures 2a through 2d.

11. Quadrangles with land loss rates greater than 1, 2, and 3 square miles per year are shown by Figures 2a through 2d for the different time periods. For time period 1 (Figure 2a), there were no quadrangles with land loss rates greater than 2 square miles per year. The number of quadrangles with land loss rates greater than 1 square mile per year is as follows: 3 quadrangles in time period 1, 17 quadrangles in time period 2, 8 quadrangles in time period 3, and 7 quadrangles in time period 4. This series of illustrations shows that the greatest land loss has occurred in the Modern Delta, the South-Central Deltaic Plain, and the Western Chenier Plain.

Land Loss Rates in Percent Per Year

12. As another method of presenting the land loss trend data, the 1930's base maps were digitized in order to determine the percentage of land loss for each quadrangle. Land loss rates as a percent of the land area present in each time period are identified in Table 3 and the individual rate curves for the percent data are presented in Appendix B. Land loss rates in Table 3 are expressed as average percent land loss per year and were derived by dividing the land loss rate (in square miles per year) for each quadrangle by the land area present at the beginning of each time period mapped. Land loss data presented as a function of percent allow comparison between quadrangles with small initial land areas and quadrangles with large land areas. With land loss rates expressed as percent loss, the comparison is independent of the total amount of land present for each quadrangle. The loss rate for each quadrangle is the amount of land loss as a percentage of the available land present. It is then possible to compare quadrangles which

Table 2
Louisiana Coastal Plain Land Loss Rates

Quadrangle Name	Time Period 1	Avg. Loss in Square miles/year	Time Period 2	Avg. Loss in Square miles/year	Time Period 3	Avg. Loss in Square miles/year	Time Period 4	Avg. Loss in Square miles/year
Abbeville	1935-1954	0.07	1954-1974	0.23	1974-1983	0.24	1983-1990	0.43
Barataria	1939-1956	1.08	1956-1974	1.20	1974-1983	0.70	1983-1990	1.06
Bay Dogris	1932-1958	0.42	1958-1974	1.44	1974-1983	1.26	1983-1990	1.15
Bayou Du Large	1932-1958	0.18	1958-1974	1.61	1974-1983	0.65	1983-1990	0.47
Bayou Sale	1937-1956	0.31	1956-1974	0.36	1974-1983	0.19	1983-1990	0.07
Belle Isle	1940-1956	0.38	1956-1974	0.32	1974-1983	0.15	1983-1990	0.07
Black Bay	1932-1958	0.21	1958-1974	0.37	1974-1983	0.52	1983-1990	0.22
Bonnet Carre	1936-1958	0.10	1958-1974	0.44	1974-1983	0.19	1983-1990	0.07
Breton Island	1932-1958	0.26	1958-1974	0.18	1974-1983	0.11	1983-1990	0.05
Caillou Bay	1932-1958	0.22	1958-1974	0.40	1974-1983	0.43	1983-1990	0.21
Cameron	1933-1955	0.08	1955-1974	2.47	1974-1983	0.60	1983-1990	0.25
Cat Island	1932-1958	0.07	1958-1974	0.09	1974-1983	0.11	1983-1990	0.07
Chef Menteur	1932-1958	0.49	1958-1974	0.41	1974-1983	0.28	1983-1990	0.28
Chen. Au Tigre	1935-1951	0.08	1951-1974	0.36	1974-1983	0.13	1983-1990	0.32
Constance Bayou	1932-1955	0.64	1955-1974	0.82	1974-1983	0.50	1983-1990	0.59
Covington	1932-1958	0.02	1958-1974	0.18	1974-1983	0.02	1983-1990	0.18
Cut Off	1939-1958	0.22	1958-1974	0.53	1974-1983	0.39	1983-1990	0.51
Derouen	1932-1956	0.24	1956-1974	0.22	1974-1983	0.24	1983-1990	0.25
Dulac	1932-1958	0.37	1958-1974	0.98	1974-1983	1.99	1983-1990	1.49
East Delta	1932-1958	1.17	1958-1974	1.90	1974-1983	0.27	1983-1990	0.34
Empire	1932-1958	0.35	1958-1974	1.12	1974-1983	2.66	1983-1990	2.08
Forked Island	1935-1955	0.01	1955-1974	0.15	1974-1983	0.14	1983-1990	0.27
Fort Livingston	1932-1958	0.34	1958-1974	0.53	1974-1983	0.89	1983-1990	0.54
Gibson	1939-1958	0.11	1958-1974	1.50	1974-1983	0.45	1983-1990	0.54
Grand Lake East	1932-1955	0.29	1955-1974	0.41	1974-1983	1.54	1983-1990	0.62
Grand Lake West	1933-1955	0.05	1955-1974	1.12	1974-1983	1.30	1983-1990	0.44
Hahnville	1935-1958	0.11	1958-1974	0.57	1974-1983	0.43	1983-1990	0.17
Hog Bayou	1932-1955	0.54	1955-1974	0.72	1974-1983	0.15	1983-1990	0.56
Houma	1939-1958	0.13	1958-1974	0.24	1974-1983	0.17	1983-1990	0.29
Jeanerette	1937-1956	0.08	1956-1974	0.08	1974-1983	0.06	1983-1990	0.10

(Continued)

Table 2 (Concluded)

Quadrangle Name	Time Period 1	Avg. Loss in Square miles/year	Time Period 2	Avg. Loss in Square miles/year	Time Period 3	Avg. Loss in Square miles/year	Time Period 4	Avg. Loss in Square miles/year
Johnsons Bayou	1933-1955	0.09	1955-1974	3.12	1974-1983	1.02	1983-1990	0.30
Lac des Allemands	1945-1958	0.13	1958-1974	0.11	1974-1983	0.66	1983-1990	0.19
Lake Decade	1931-1956	0.25	1956-1974	1.31	1974-1983	0.38	1983-1990	0.26
Lake Felicity	1932-1958	0.29	1958-1974	1.32	1974-1983	1.61	1983-1990	1.35
Leeville	1932-1958	0.28	1958-1974	0.40	1974-1983	0.90	1983-1990	0.73
Marsh Island	1932-1956	0.23	1956-1974	0.39	1974-1983	0.24	1983-1990	0.25
Mitchell Key	1932-1956	0.05	1956-1974	0.03	1974-1983	0.07	1983-1990	0.02
Morgan City	1931-1956	0.20	1956-1974	1.37	1974-1983	0.93	1983-1990	0.31
Morgan Harbor	1932-1958	0.19	1958-1974	0.32	1974-1983	0.38	1983-1990	0.32
Mount Airy	1939-1958	0.05	1958-1974	0.08	1974-1983	0.08	1983-1990	0.12
New Orleans	1935-1958	0.17	1958-1974	0.26	1974-1983	0.14	1983-1990	0.15
Oyster Bayou	1931-1956	0.07	1956-1974	0.18	1974-1983	0.15	1983-1990	0.07
Pecan Island	1935-1951	0.06	1951-1974	0.79	1974-1983	0.75	1983-1990	0.62
Point Chicot	1932-1958	0.08	1958-1974	0.08	1974-1983	0.07	1983-1990	0.15
Point au Fer	1931-1956	0.11	1956-1974	0.16	1974-1983	0.17	1983-1990	0.11
Pointe ala Hache	1932-1958	0.28	1958-1974	0.75	1974-1983	0.71	1983-1990	0.75
Pontchatoula	1939-1958	0.07	1958-1974	0.09	1974-1983	0.08	1983-1990	0.05
Rigolets	1932-1958	0.11	1958-1974	0.24	1974-1983	0.26	1983-1990	0.12
Slidell	1939-1958	0.06	1958-1974	0.15	1974-1983	0.05	1983-1990	0.04
Southwest Pass	1932-1958	0.10	1958-1974	0.12	1974-1983	0.02	1983-1990	0.02
Spanish Fort	1936-1958	0.03	1958-1974	0.01	1974-1983	0.003	1983-1990	0.01
Springfield	1939-1958	0.01	1958-1974	0.01	1974-1983	0.03	1983-1990	0.003
St. Bernard	1932-1958	0.29	1958-1974	1.23	1974-1983	0.70	1983-1990	0.26
Sulphur	1933-1955	0.05	1955-1974	1.82	1974-1983	0.40	1983-1990	0.28
Sweet Lake	1933-1955	0.13	1955-1974	1.80	1974-1983	0.84	1983-1990	0.68
Terrebonne Bay	1932-1958	0.18	1958-1974	0.29	1974-1983	0.49	1983-1990	0.35
Thibodaux	1949-1958	0.003	1958-1974	0.02	1974-1983	0.07	1983-1990	0.26
Three Mile Bay	1932-1958	0.08	1958-1974	0.11	1974-1983	0.10	1983-1990	0.19
Timbalier Bay	1932-1958	0.21	1958-1974	0.22	1974-1983	0.41	1983-1990	0.31
Venice	1932-1958	0.61	1958-1974	1.50	1974-1983	0.54	1983-1990	1.60
West Delta	1932-1958	1.41	1958-1974	2.00	1974-1983	1.04	1983-1990	1.64
Yscloskey	1932-1958	0.12	1958-1974	0.60	1974-1983	0.53	1983-1990	0.14

LAND LOSS RATES
TIME 1 (1930's–1956-58)

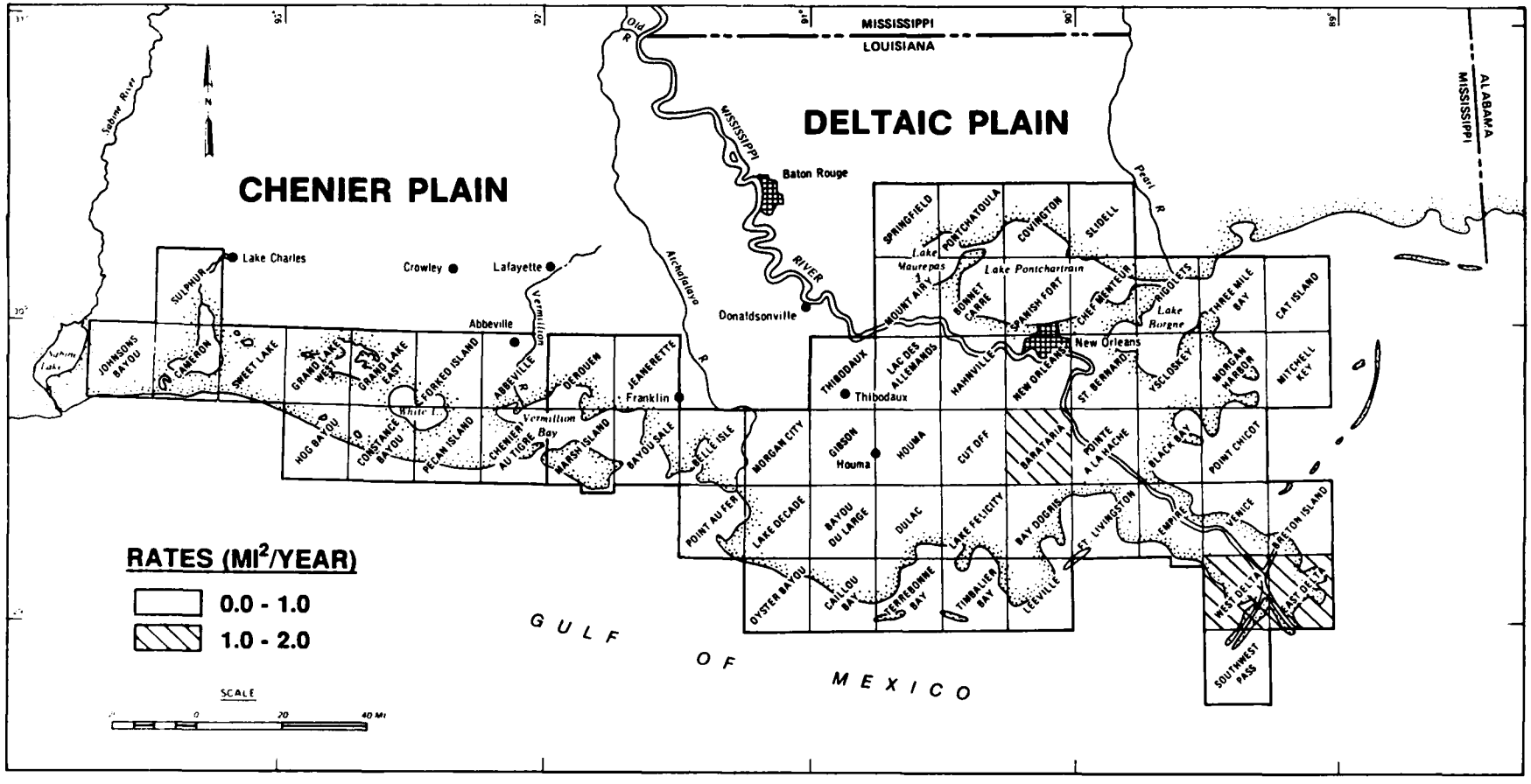


Figure 2a. Summary of land loss rates in square miles per year for time period 1 (1930's to 1956-58)

LAND LOSS RATES
TIME 2 (1956-58–1974)

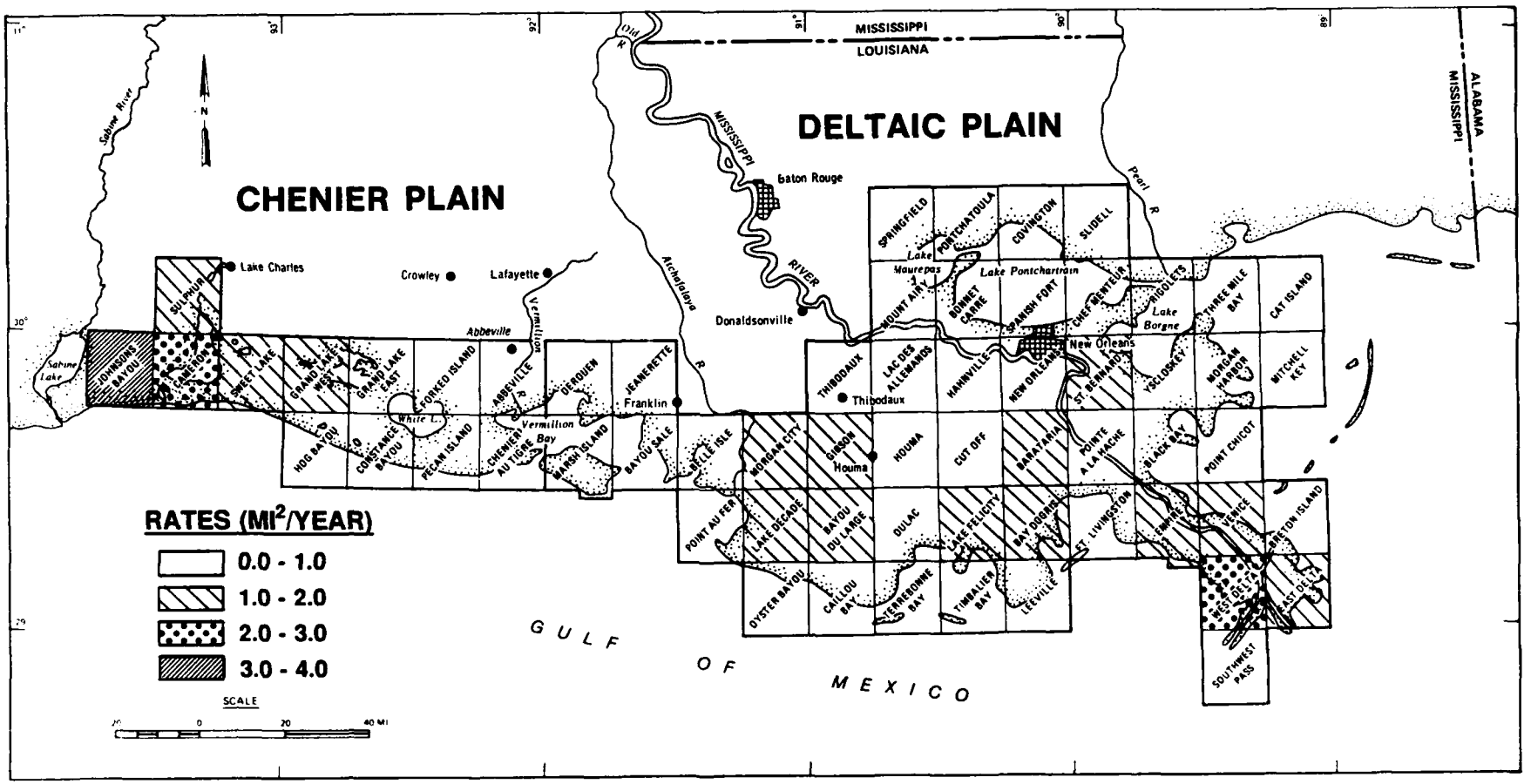


Figure 2b. Summary of land loss rates in square miles per year for time period 2 (1956-58 to 1974)

LAND LOSS RATES
TIME 3 (1974–1983)

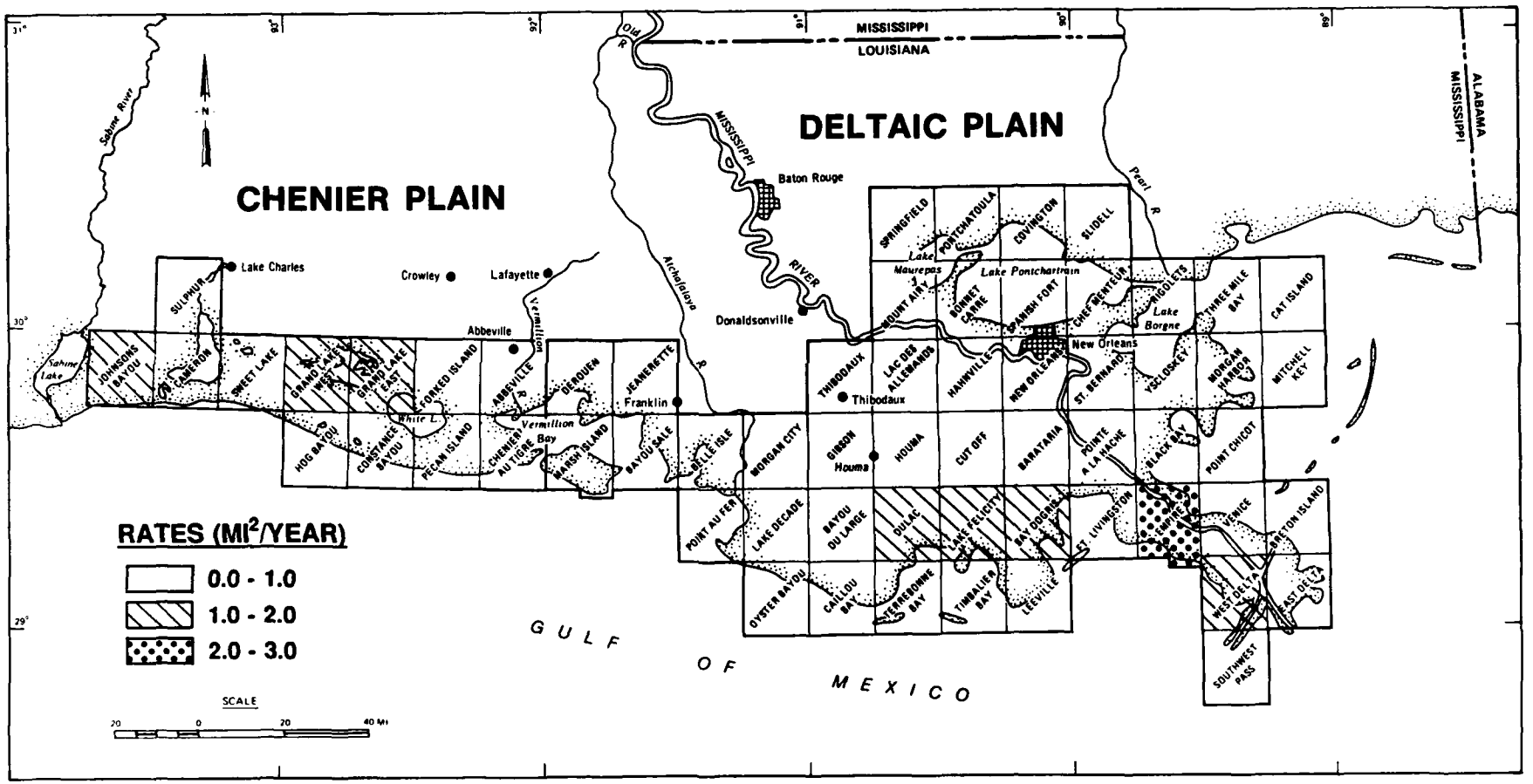


Figure 2c. Summary of land loss rates in square miles per year for time period 3 (1974 to 1983)

LAND LOSS RATES
TIME 4 (1983–1990)

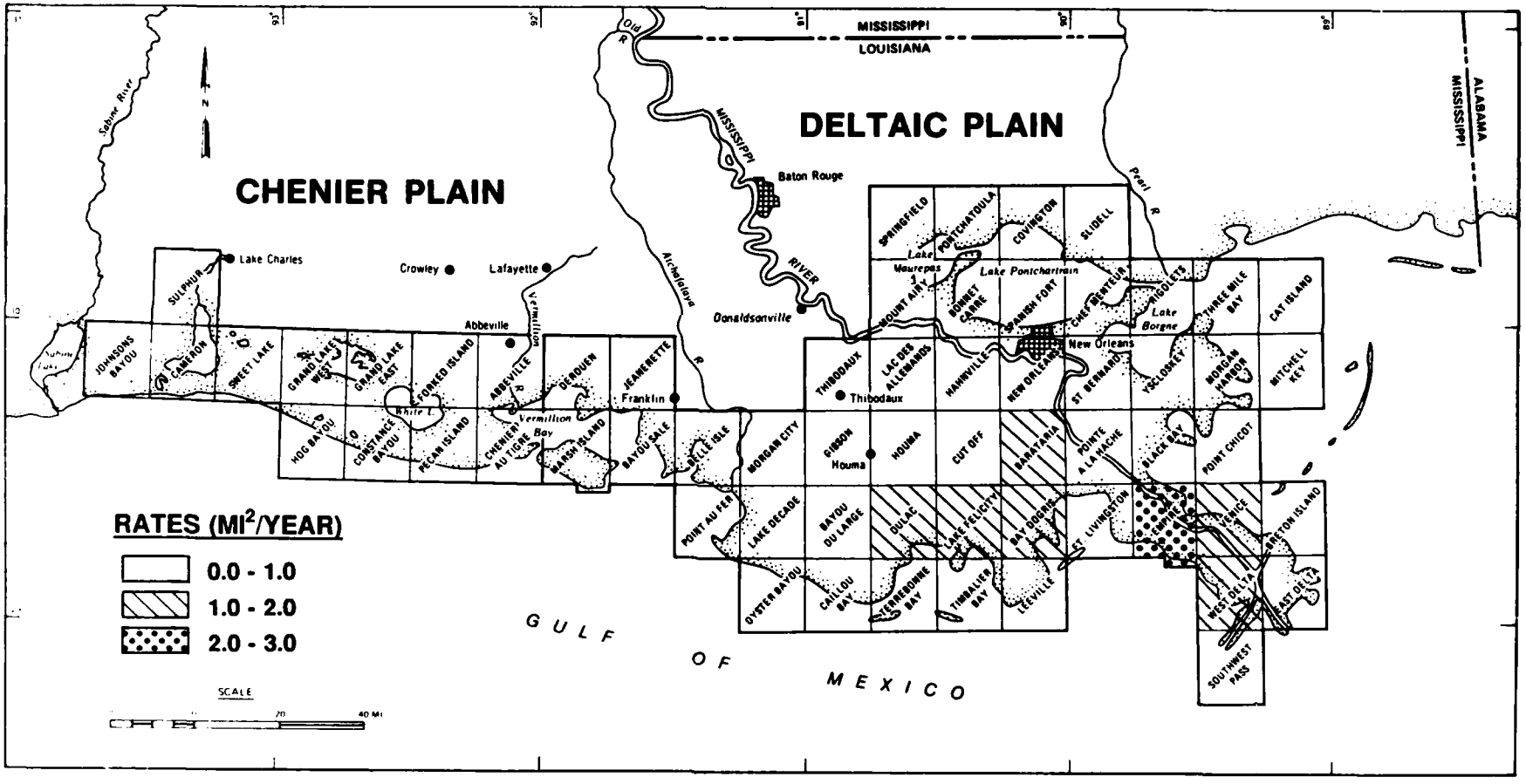


Figure 2d. Summary of land loss rates in square miles per year for time period 4 (1983 to 1990)

Table 3
Louisiana Coastal Plain Average Percent Land Loss Rates

Quadrangle Name	Time Period 1	Average Percent Loss/Year	Time Period 2	Average Percent Loss/Year	Time Period 3	Average Percent Loss/Year	Time Period 4	Average Percent Loss/Year
Abbeville	1935-1954	0.08	1954-1974	0.25	1974-1983	0.27	1983-1990	0.50
Barataria	1939-1956	0.56	1956-1974	0.69	1974-1983	0.46	1983-1990	0.73
Bay Dogris	1932-1958	0.24	1958-1974	0.89	1974-1983	0.91	1983-1990	0.90
Bayou Du Large	1932-1958	0.08	1958-1974	0.77	1974-1983	0.36	1983-1990	0.27
Bayou Sale	1937-1956	0.35	1956-1974	0.44	1974-1983	0.26	1983-1990	0.10
Belle Isle	1940-1956	0.17	1956-1974	0.15	1974-1983	0.07	1983-1990	0.03
Black Bay	1932-1958	0.21	1958-1974	0.39	1974-1983	0.58	1983-1990	0.26
Bonnet Carre	1936-1958	0.09	1958-1974	0.41	1974-1983	0.19	1983-1990	0.07
Breton Island	1932-1958	1.42	1958-1974	1.55	1974-1983	1.26	1983-1990	0.65
Caillou Bay	1932-1958	0.26	1958-1974	0.50	1974-1983	0.59	1983-1990	0.30
Cameron	1933-1955	0.05	1955-1974	1.55	1974-1983	0.53	1983-1990	0.23
Cat Island	1932-1958	0.61	1958-1974	0.92	1974-1983	1.33	1983-1990	0.96
Chef Menteur	1932-1958	0.48	1958-1974	0.46	1974-1983	0.34	1983-1990	0.35
Chen. Au Tigre	1935-1951	0.08	1951-1974	0.38	1974-1983	0.15	1983-1990	0.37
Constance Bayou	1932-1955	0.43	1955-1974	0.62	1974-1983	0.43	1983-1990	0.52
Covington	1932-1958	0.03	1958-1974	0.27	1974-1983	0.03	1983-1990	0.28
Cut Off	1939-1958	0.10	1958-1974	0.24	1974-1983	0.19	1983-1990	0.25
Derouen	1932-1956	0.12	1956-1974	0.11	1974-1983	0.12	1983-1990	0.13
Dulac	1932-1958	0.18	1958-1974	0.51	1974-1983	1.13	1983-1990	0.94
East Delta	1932-1958	1.16	1958-1974	2.70	1974-1983	0.68	1983-1990	0.91
Empire	1932-1958	0.22	1958-1974	0.75	1974-1983	2.01	1983-1990	1.92
Forked Island	1935-1955	0.01	1955-1974	0.12	1974-1983	0.11	1983-1990	0.22
Fort Livingston	1932-1958	0.40	1958-1974	0.69	1974-1983	1.31	1983-1990	0.90
Gibson	1939-1958	0.04	1958-1974	0.59	1974-1983	0.20	1983-1990	0.24
Grand Lake East	1932-1955	0.16	1955-1974	0.24	1974-1983	0.95	1983-1990	0.41
Grand Lake West	1933-1955	0.02	1955-1974	0.53	1974-1983	0.68	1983-1990	0.25
Hahnville	1935-1958	0.05	1958-1974	0.24	1974-1983	0.19	1983-1990	0.08
Hog Bayou	1932-1955	0.66	1955-1974	1.04	1974-1983	0.27	1983-1990	1.04
Houma	1939-1958	0.05	1958-1974	0.10	1974-1983	0.07	1983-1990	0.12
Jeanerette	1937-1956	0.05	1956-1974	0.05	1974-1983	0.04	1983-1990	0.07

(Continued)

Table 3 (Concluded)

Quadrangle Name	Time Period 1	Average Percent Loss/Year	Time Period 2	Average Percent Loss/Year	Time Period 3	Average Percent Loss/Year	Time Period 4	Average Percent Loss/Year
Johnsons Bayou	1933-1955	0.04	1955-1974	1.23	1974-1983	0.53	1983-1990	0.16
Lac des Allemands	1945-1958	0.06	1958-1974	0.05	1974-1983	0.29	1983-1990	0.09
Lake Decade	1931-1956	0.13	1956-1974	0.69	1974-1983	0.23	1983-1990	0.16
Lake Felicity	1932-1958	0.14	1958-1974	0.67	1974-1983	0.91	1983-1990	0.83
Leeville	1932-1958	0.33	1958-1974	0.52	1974-1983	1.28	1983-1990	1.17
Marsh Island	1932-1956	0.21	1956-1974	0.38	1974-1983	0.25	1983-1990	0.27
Mitchell Key	1932-1956	1.24	1956-1974	0.74	1974-1983	3.06	1983-1990	1.20
Morgan City	1931-1956	0.09	1956-1974	0.64	1974-1983	0.49	1983-1990	0.17
Morgan Harbor	1932-1958	0.18	1958-1974	0.31	1974-1983	0.39	1983-1990	0.34
Mount Airy	1939-1958	0.02	1958-1974	0.04	1974-1983	0.04	1983-1990	0.05
New Orleans	1935-1958	0.08	1958-1974	0.12	1974-1983	0.07	1983-1990	0.07
Oyster Bayou	1931-1956	0.20	1956-1974	0.54	1974-1983	0.50	1983-1990	0.24
Pecan Island	1935-1951	0.03	1951-1974	0.44	1974-1983	0.47	1983-1990	0.40
Point Chicot	1932-1958	0.66	1958-1974	0.80	1974-1983	0.81	1983-1990	1.86
Point au Fer	1931-1956	0.33	1956-1974	0.53	1974-1983	0.62	1983-1990	0.42
Pointe ala Hache	1932-1958	0.13	1958-1974	0.37	1974-1983	0.37	1983-1990	0.40
Pontchatoula	1939-1958	0.05	1958-1974	0.07	1974-1983	0.06	1983-1990	0.04
Rigolets	1932-1958	0.10	1958-1974	0.23	1974-1983	0.26	1983-1990	0.12
Slidell	1939-1958	0.09	1958-1974	0.24	1974-1983	0.08	1983-1990	0.07
Southwest Pass	1932-1958	1.45	1958-1974	2.82	1974-1983	0.86	1983-1990	0.93
Spanish Fort	1936-1958	0.10	1958-1974	0.03	1974-1983	0.01	1983-1990	0.03
Springfield	1939-1958	0.01	1958-1974	0.01	1974-1983	0.03	1983-1990	0.003
St. Bernard	1932-1958	0.14	1958-1974	0.61	1974-1983	0.38	1983-1990	0.15
Sulphur	1933-1955	0.02	1955-1974	0.78	1974-1983	0.20	1983-1990	0.14
Sweet Lake	1933-1955	0.05	1955-1974	0.77	1974-1983	0.42	1983-1990	0.35
Terrebonne Bay	1932-1958	0.40	1958-1974	0.73	1974-1983	1.39	1983-1990	1.13
Thibodaux	1949-1958	0.001	1958-1974	0.01	1974-1983	0.03	1983-1990	0.10
Three Mile Bay	1932-1958	0.26	1958-1974	0.38	1974-1983	0.36	1983-1990	0.72
Timbalier Bay	1932-1958	0.91	1958-1974	1.26	1974-1983	2.93	1983-1990	3.01
Venice	1932-1958	0.63	1958-1974	1.87	1974-1983	0.96	1983-1990	3.11
West Delta	1932-1958	1.23	1958-1974	2.55	1974-1983	2.24	1983-1990	4.42
Yscloskey	1932-1958	0.08	1958-1974	0.40	1974-1983	0.38	1983-1990	0.10

contain little land area (i.e., Cat Island, Mitchell Key, Point Chicot, etc.) with quadrangles that are nearly all land (Cut Off, Gibson, Houma, etc.). Table 3 shows that quadrangles with little land area have some of the highest land loss rates in the study area.

13. A summary of land loss rates expressed as average percent per year for the different time periods mapped is presented in Figures 3a through 3d. For time period 1, the maximum rate is less than 2 percent per year. In time periods 2, 3, and 4, the maximum rates are greater than 2 percent per year. Comparing quadrangles with loss rates greater than 0.5 percent over the four time periods mapped shows rather specific trends for the past 60 years. The 0.5 percent rate is empirically established for comparison purposes. The highest land loss rates based on percentage change are occurring along the coast. Percentage loss rates are highest in the Modern Delta, in the coastal quadrangles of the Eastern and Southern Deltaic Plain, and in the Western Chenier Plain. Percentage land loss rate trends are generally consistent among the four time periods mapped for these same areas except for the Western Chenier Plain, where the rates are more variable

1930's Base Land and Water Data

14. From the 1930's land data, it is possible to determine the gross land changes that have occurred in coastal Louisiana. Beginning in the early 1930's, there was approximately 8,511 square miles of land in the study area. By the end of the 1990 time period, the total land loss that occurred was 1,526 square miles or approximately 17.8 percent of the original land area. Of the 17.8 percent total loss, 74.4 percent occurred in the Deltaic Plain and 25.6 percent in the Chenier Plain. Figure 4 summarizes the general land changes that have occurred in coastal Louisiana during approximately the past 60 years and shows the percent contribution that occurred in each period. In time period 2 (1956-58 to 1974), the greatest amount of land was lost with nearly half of the total loss occurring during this period. For time periods 3 and 4, the loss contribution has decreased for each period from the proceeding time period.

AVG PERCENT LAND LOSS PER YEAR
TIME 1 (1930's–1956-58)

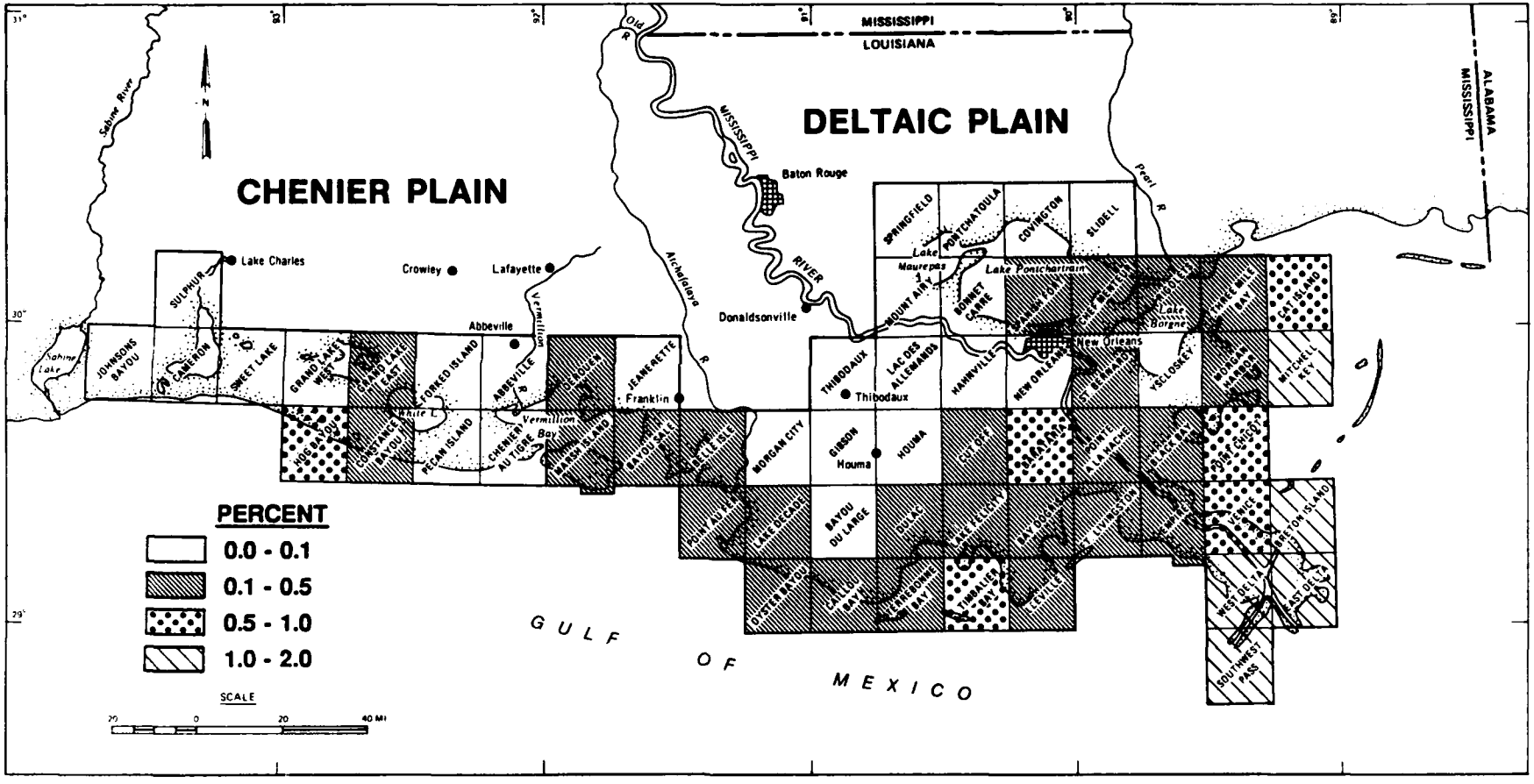


Figure 3a. Summary of land loss rates in percent per year for time period 1 (1930's to 1956-58)

AVG PERCENT LAND LOSS PER YEAR
TIME 2 (1956-58–1974)

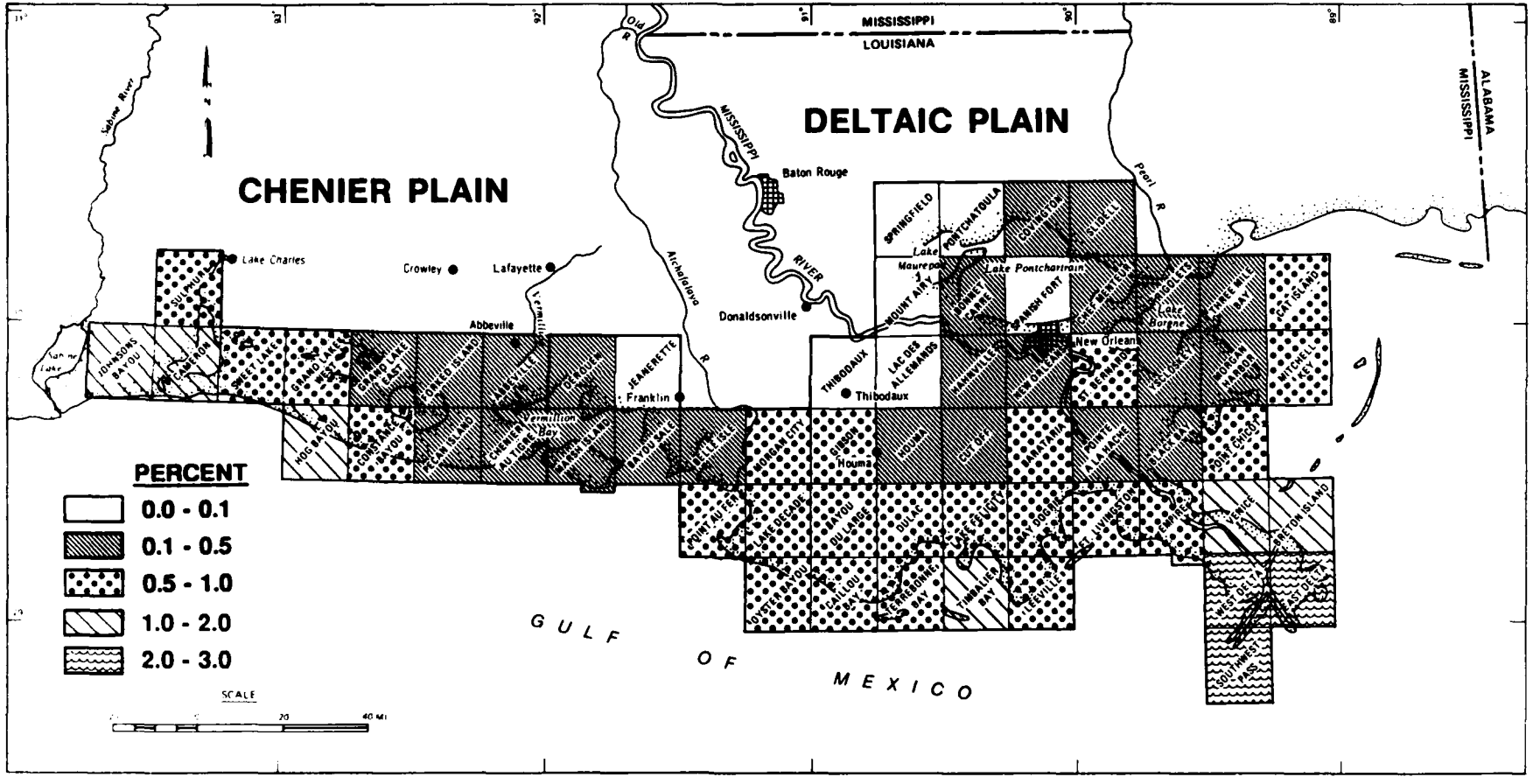


Figure 3b. Summary of land loss rates in percent per year for time period 2 (1956-58 to 1974)

AVG PERCENT LAND LOSS PER YEAR
TIME 3 (1974–1983)

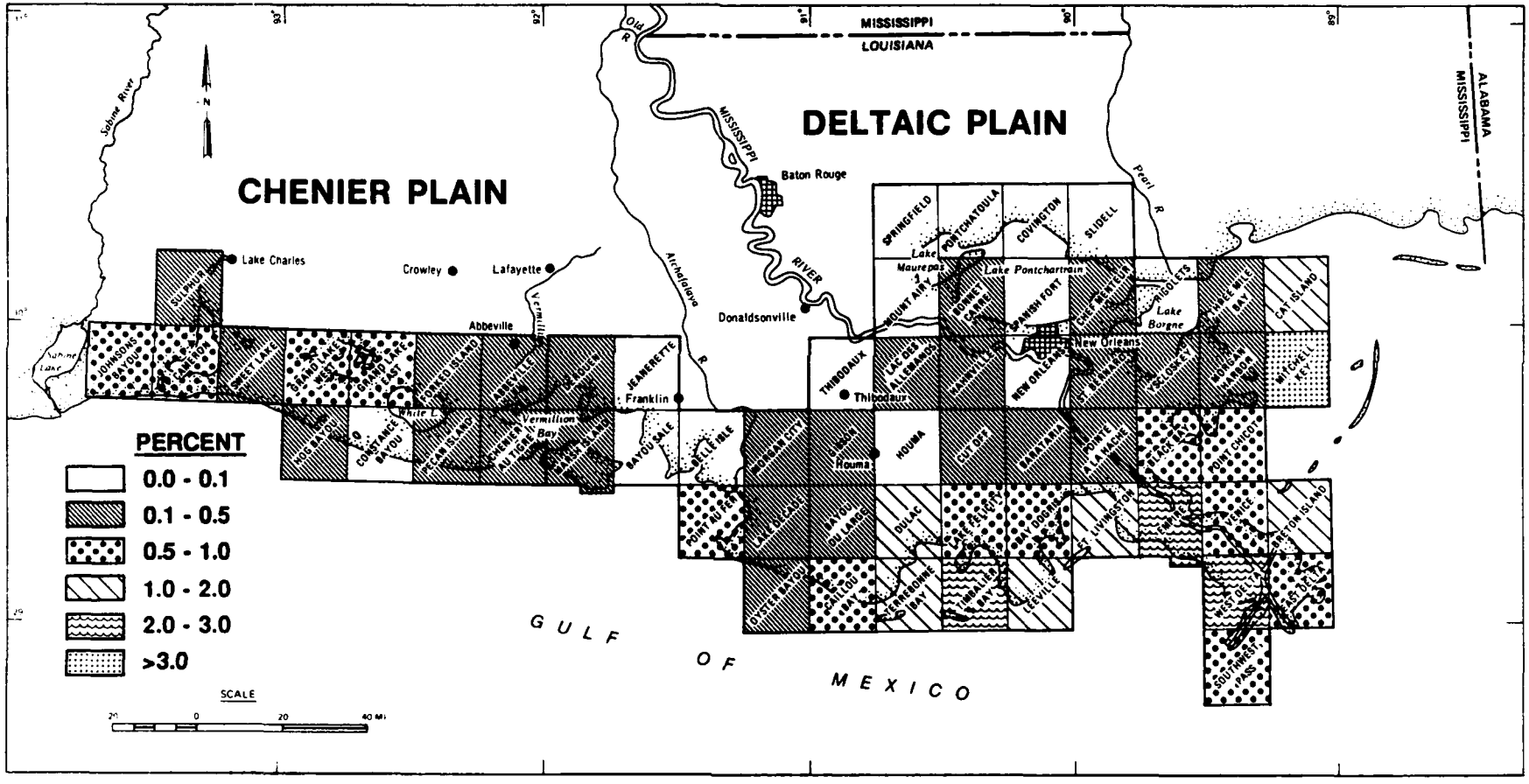


Figure 3c. Summary of land loss rates in percent per year for time period 3 (1974 to 1983)

AVG PERCENT LAND LOSS PER YEAR
TIME 4 (1983–1990)

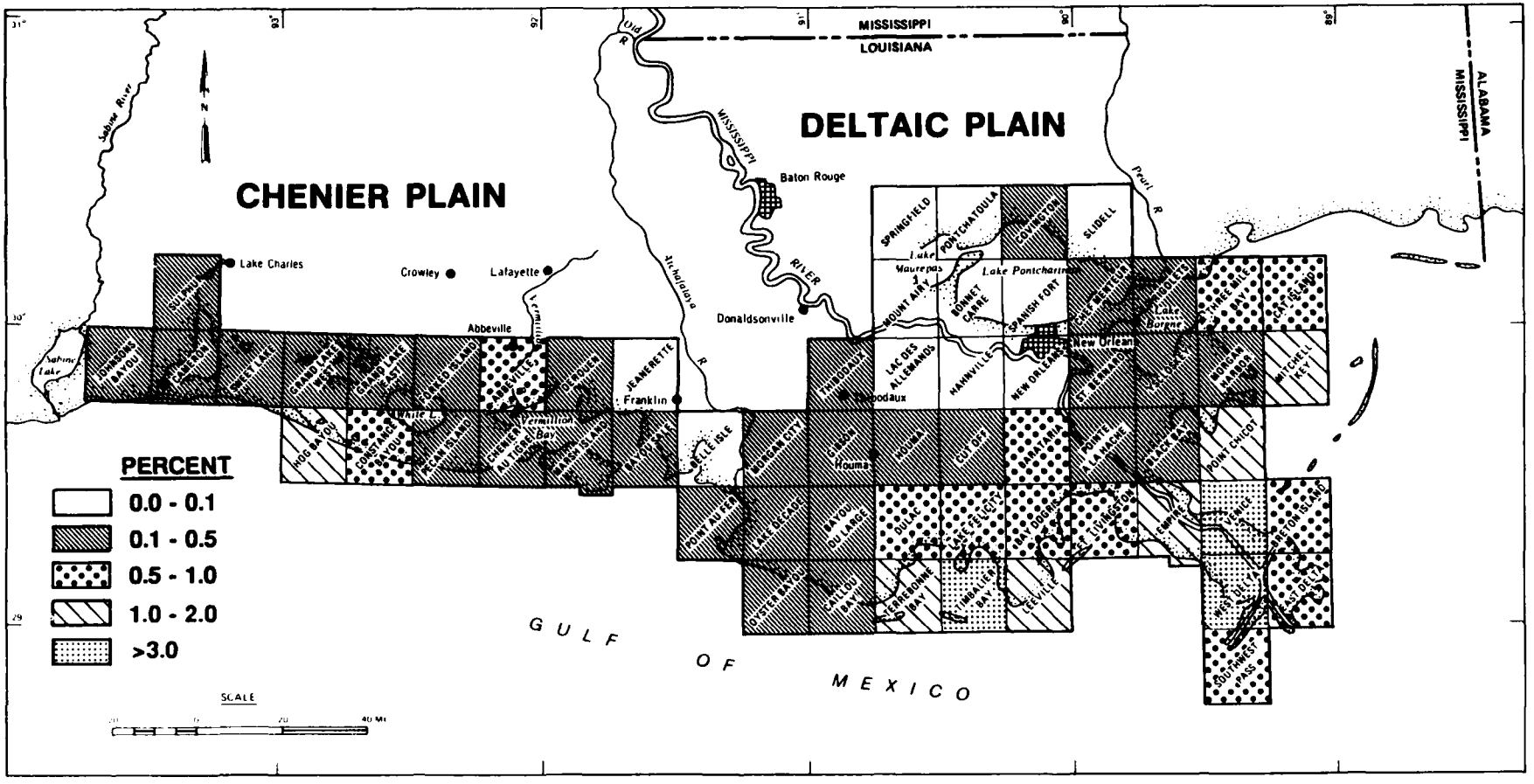


Figure 3d. Summary of land loss rates in percent per year for time period 4 (1983 to 1990)

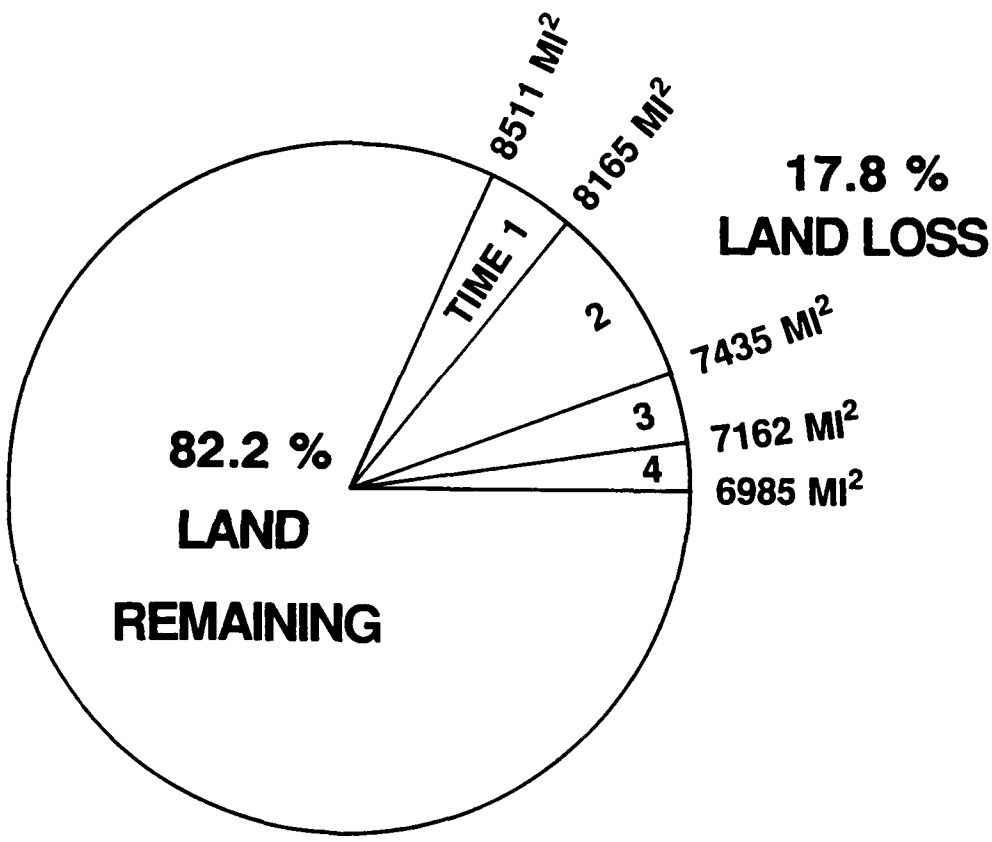


Figure 4. Pie chart showing gross land loss changes between the 1930's and 1990. Time periods mapped are as follows: Time 1 (1930's to 1956-58), Time 2 (1956-58 to 1974), Time 3 (1974 to 1983), Time 4 (1983 to 1990)

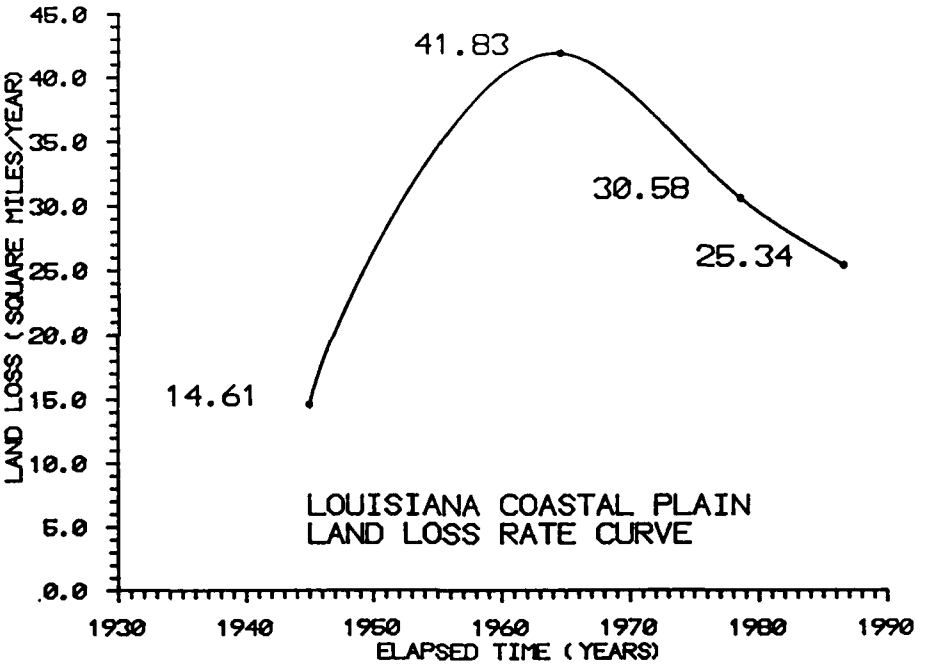
Composite Land Loss Rates

Louisiana Coastal Plain

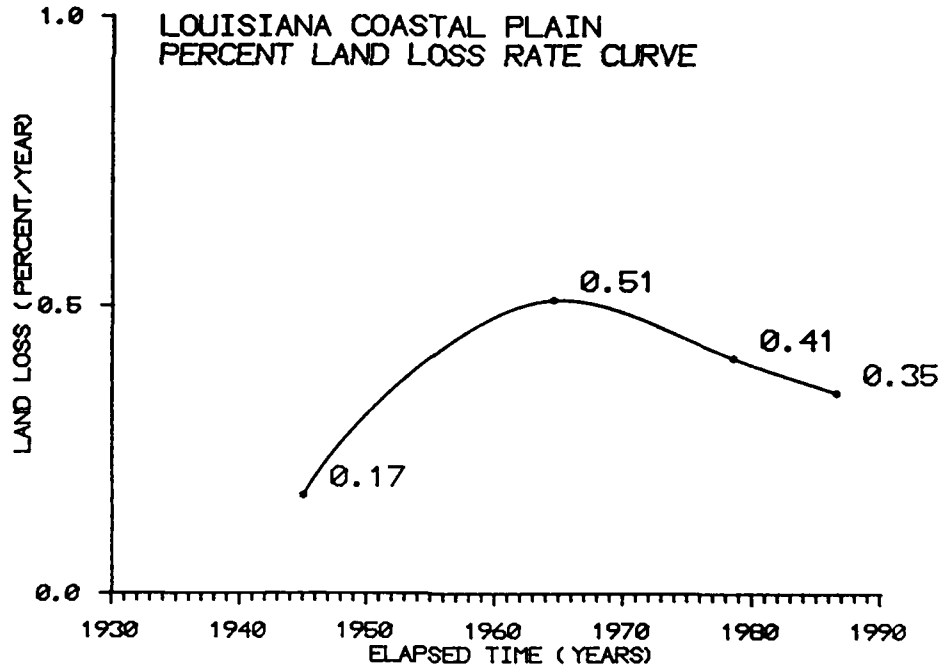
15. Composite land loss rate curves for the entire study area (see Figure 1) are presented in Figure 5. The curves are expressed in square miles per year and average percent per year, respectively. The land loss rate in time period 4 (1983 to 1990) for the Louisiana Coastal Plain is 25.34 square miles per year or 0.35 percent per year. The rate curves show the trend has been consistently decreasing from its peak in time period 2.

Mississippi River Deltaic and Chenier Plains

16. Land loss rate curves for the Deltaic Plain are presented in Figure 6. For time period 4, the land loss rate for the Deltaic Plain (50 quadrangles, see Figure 1) is 19.98 square miles per year or 0.36 percent per year. Land loss rate curves for the Chenier Plain (12 quadrangles) are presented in Figure 7. For time period 4, the land loss rate for the Chenier Plain is 5.36 square miles per year or 0.33 percent per year. For both the Deltaic and Chenier Plains, the cumulative land loss rate has been decreasing since time period 2.

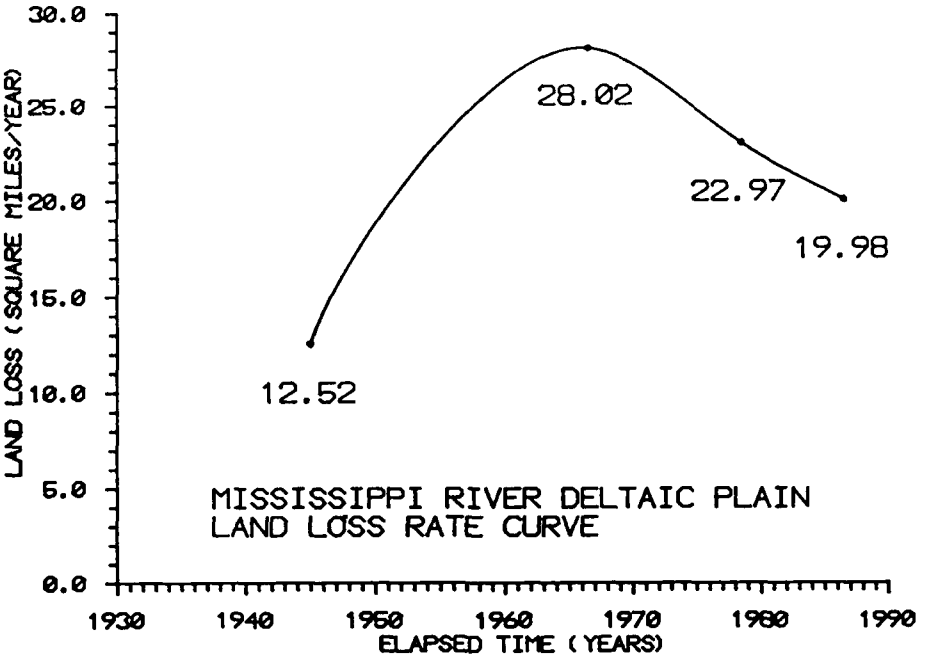


a. Curve expressed in square miles per year

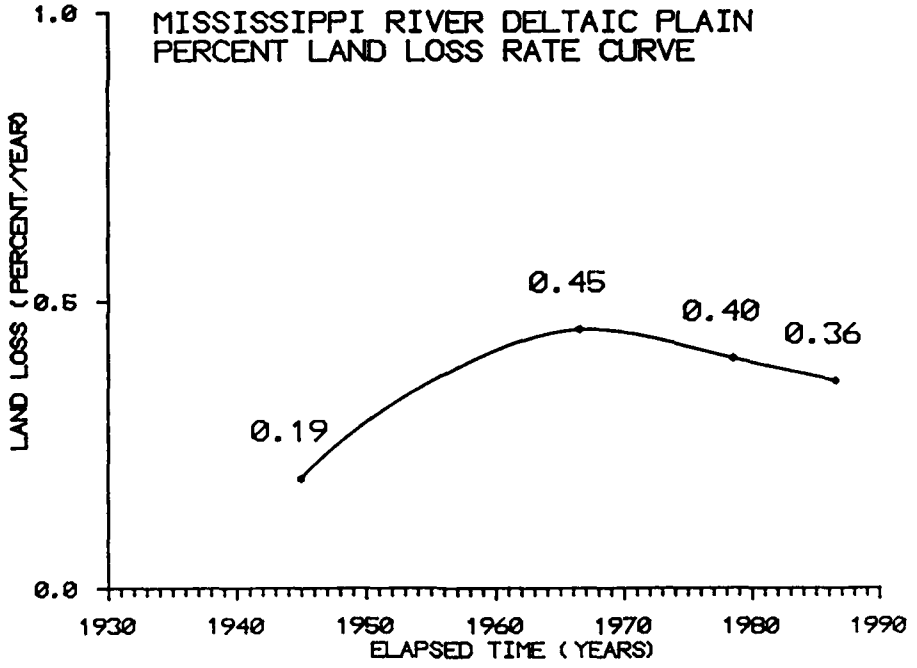


b. Curve expressed in percent per year

Figure 5. Land loss rate curves for the Louisiana Coastal Plain

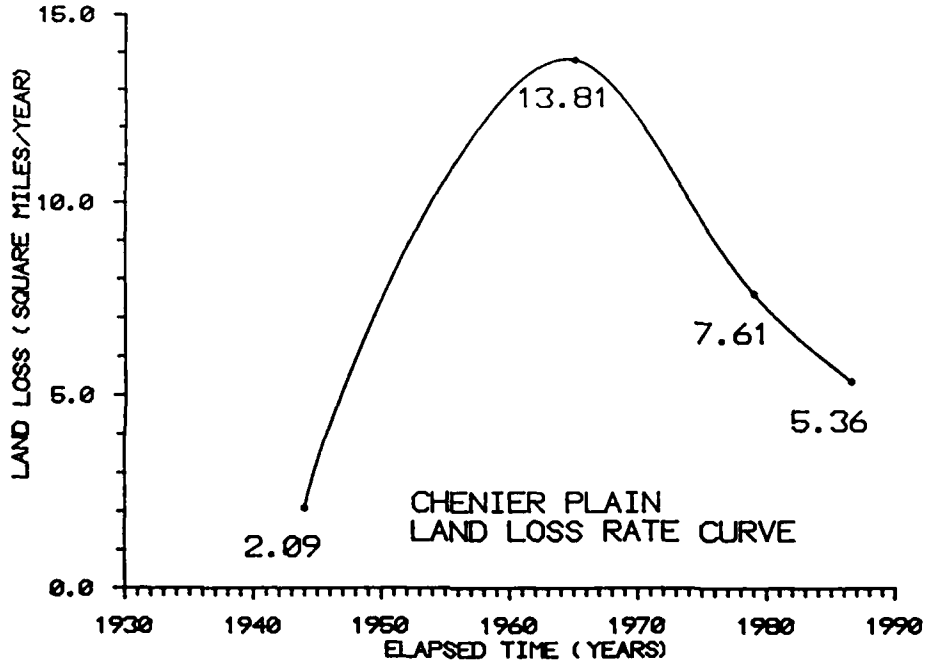


a. Curve expressed in square miles per year

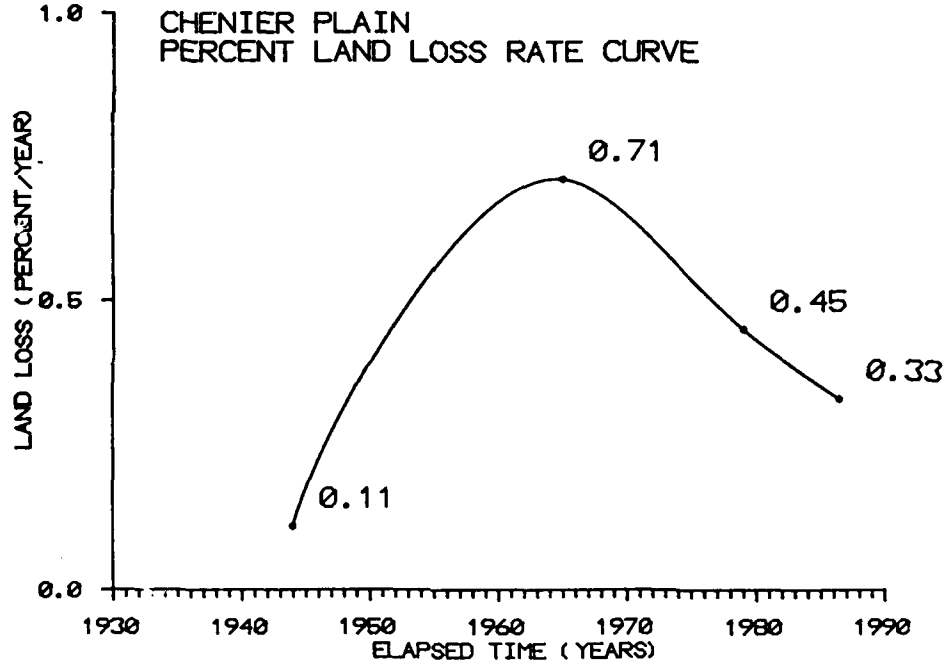


b. Curve expressed in percent per year

Figure 6. Land loss rate curves for the Mississippi River Deltaic Plain



a. Curve expressed in square miles per year



b. Curve expressed in percent per year

Figure 7. Land loss rate curves for the Chenier Plain

PART IV: CONCLUSIONS

17. Land loss mapping from the 1930's to 1990 for 62 USGS quadrangles in the Louisiana Coastal Plain indicates:

a. The location and magnitude of land loss is highly variable throughout the coastal plain.

b. The land loss rate for the entire study area has decreased from its high of approximately 42 square miles per year in 1974 to approximately 25 square miles per year in 1990.

c. The percentage of land being lost in the study area is also decreasing from its high of approximately 0.51 percent per year in 1974 to approximately 0.35 percent per year in 1990.

d. Total land area has decreased from 8,511 square miles in the 1930's to 6,985 square miles in 1990.

e. Approximately 17.8 percent of the available land in the study area has been lost since the 1930's.

f. The highest land loss rates and percentage loss are occurring along the coastline. Rates are highest in the Modern Delta and in the eastern and south-central portions of the Deltaic Plain.

g. Natural land loss rates will probably continue to decrease slowly until a background rate is reached. The land loss rate for time period 1 (14.61 square miles per year or 0.17 percent per year) may be representative of the natural background rate because it reflects the land loss rate in the coastal area prior to the major impacts from man's activities.

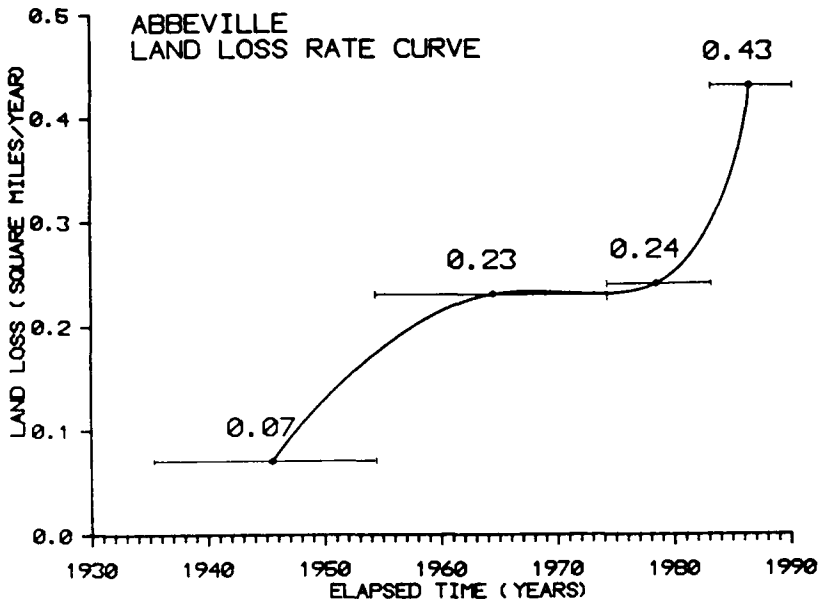
h. Land loss data are being used in conjunction with engineering geology and subsidence data to identify those areas where mitigation and/or restoration is most feasible.

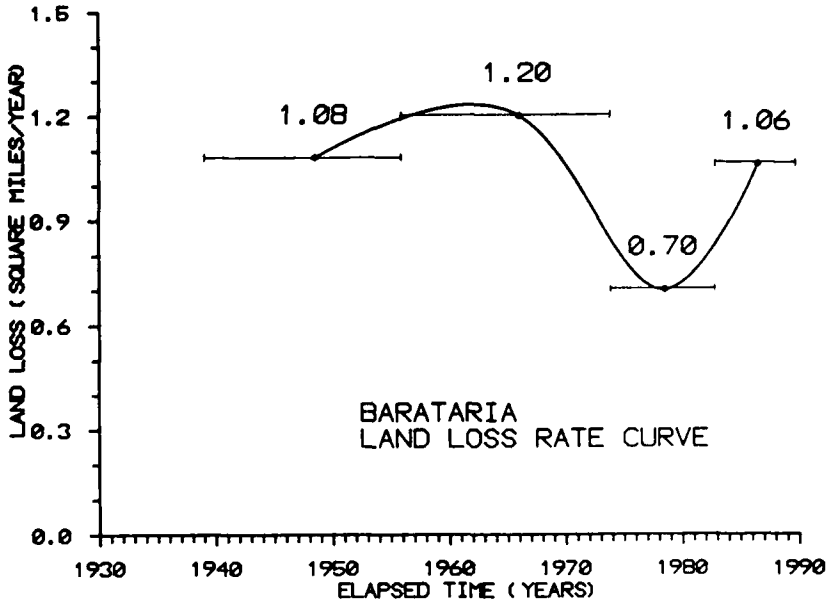
REFERENCES

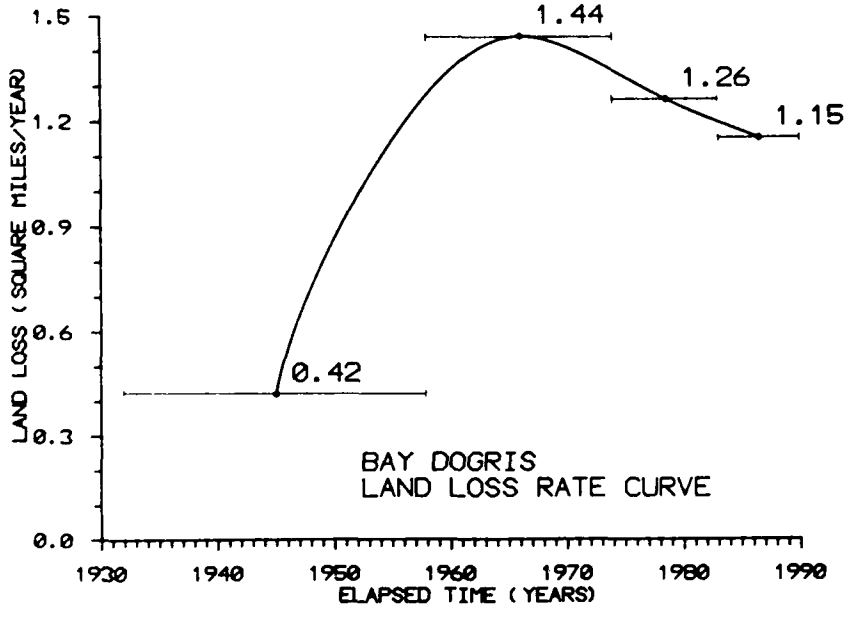
Dunbar, J. B., Britsch, L. D., and Kemp, E. B. 1990. "Land Loss Rates: Report 2, Louisiana Chenier Plain," Technical Report GL-90-2, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

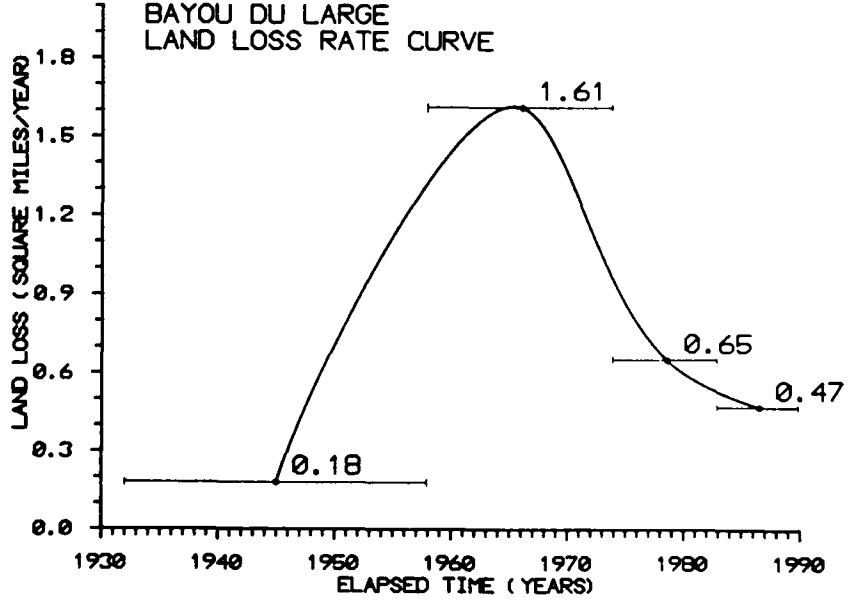
Britsch, L. D. and Kemp, E. B. 1990. "Land Loss Rates: Mississippi River Deltaic Plain," Technical Report GL-90-2, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

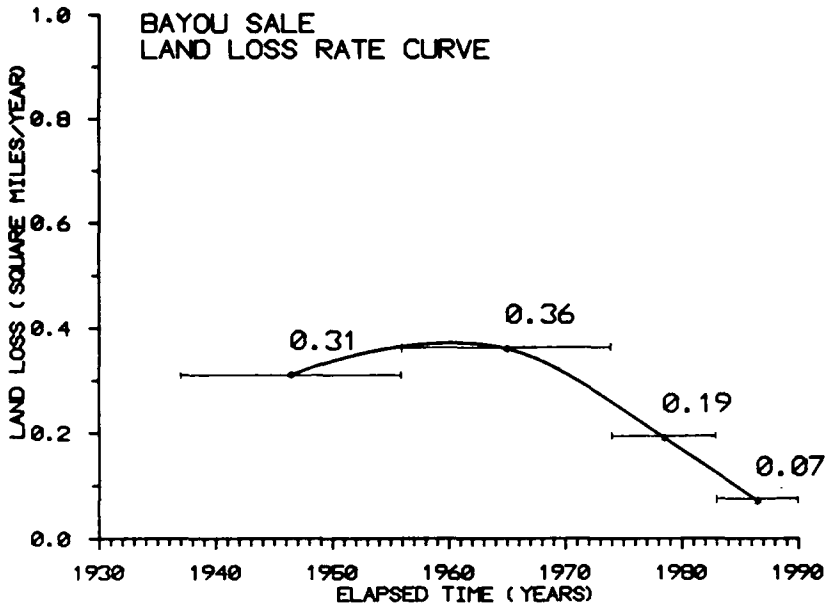
APPENDIX A: LAND LOSS RATE CURVES

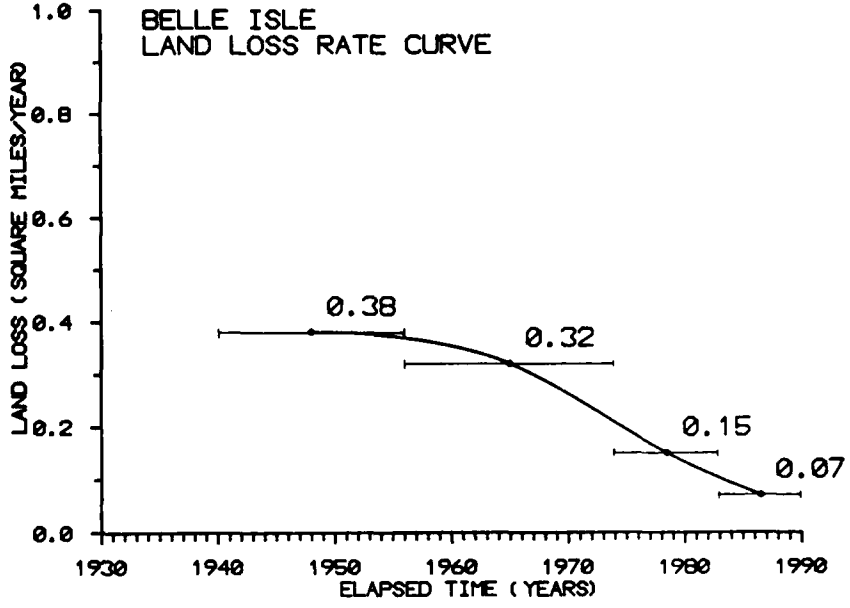

ABBEVILLE
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
ELAPSED TIME (YEARS)
0.07
0.23
0.24
0.43
0.0
0.1
0.2
0.3
0.4
0.5
1930
1940
1950
1960
1970
1980
1990

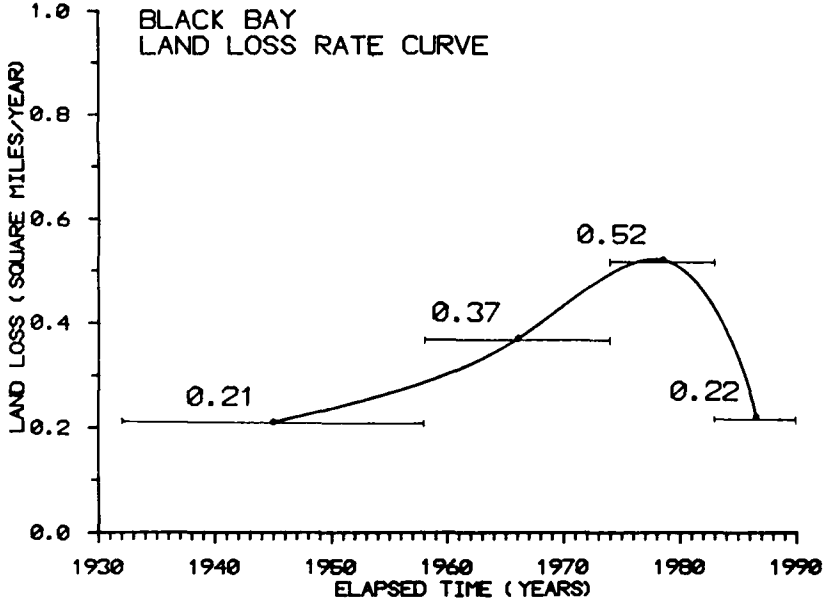

BARATARIA
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
ELAPSED TIME (YEARS)
1.08
1.20
0.70
1.06
0.0
0.3
0.6
0.9
1.2
1.5
1930
1940
1950
1960
1970
1980
1990

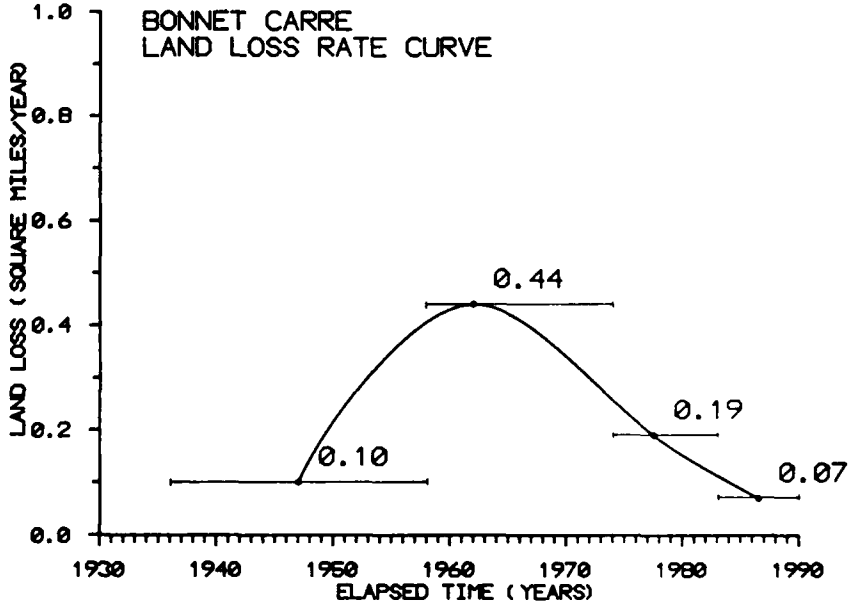

BAY DOGRIS
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
ELAPSED TIME (YEARS)
0.42
1.44
1.26
1.15
0.0
0.3
0.6
0.9
1.2
1.5
1930
1940
1950
1960
1970
1980
1990

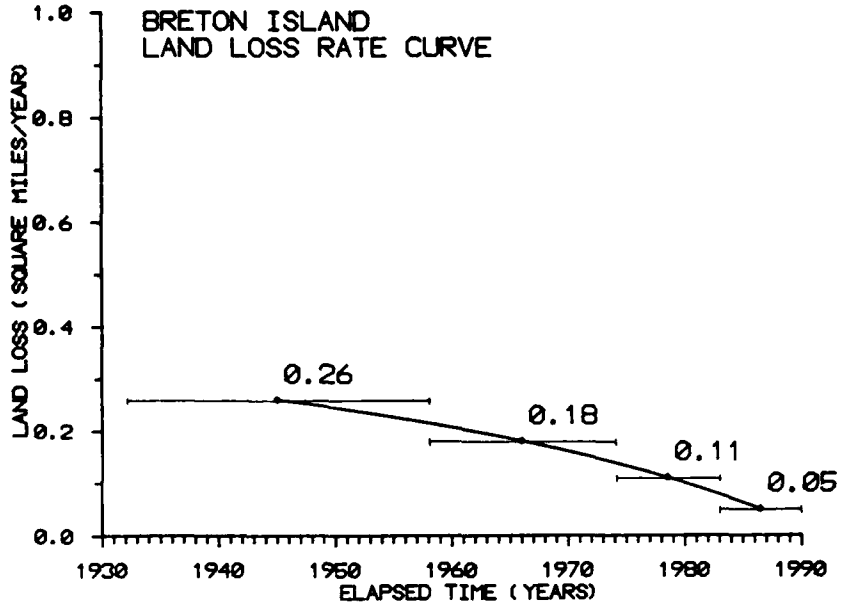

BAYOU DU LARGE
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
ELAPSED TIME (YEARS)
0.18
1.61
0.65
0.47
0.0
0.3
0.6
0.9
1.2
1.5
1.8
1930
1940
1950
1960
1970
1980
1990

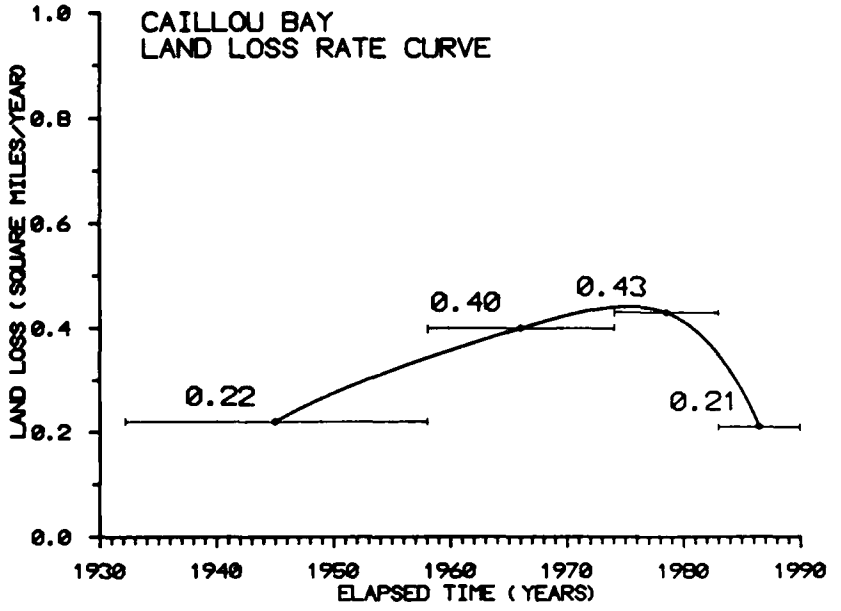

BAYOU SALE
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
1.0
0.8
0.6
0.4
0.2
0.0
0.31
0.36
0.19
0.07
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

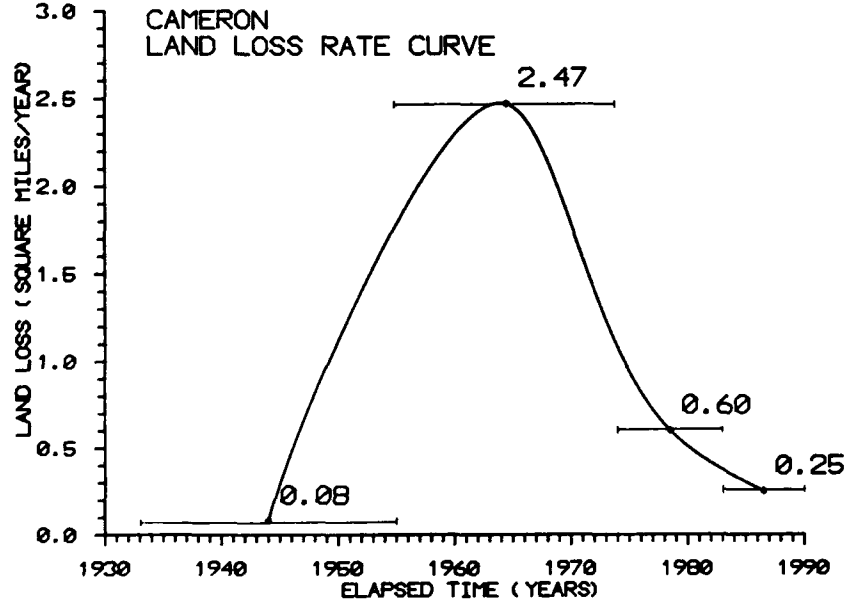

BELLE ISLE
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
1.0
0.8
0.6
0.4
0.2
0.0
0.38
0.32
0.15
0.07
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

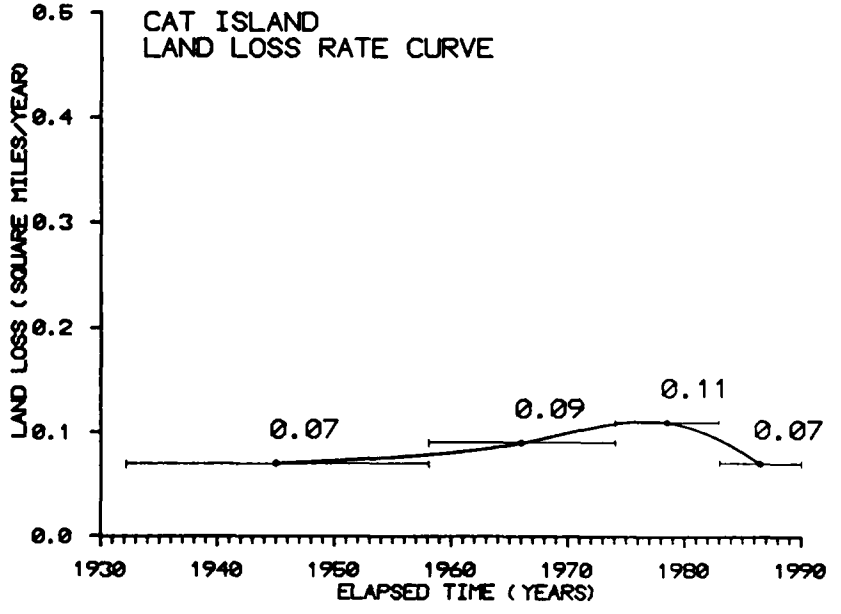

BLACK BAY
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
1.0
0.8
0.6
0.4
0.2
0.0
0.21
0.37
0.52
0.22
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

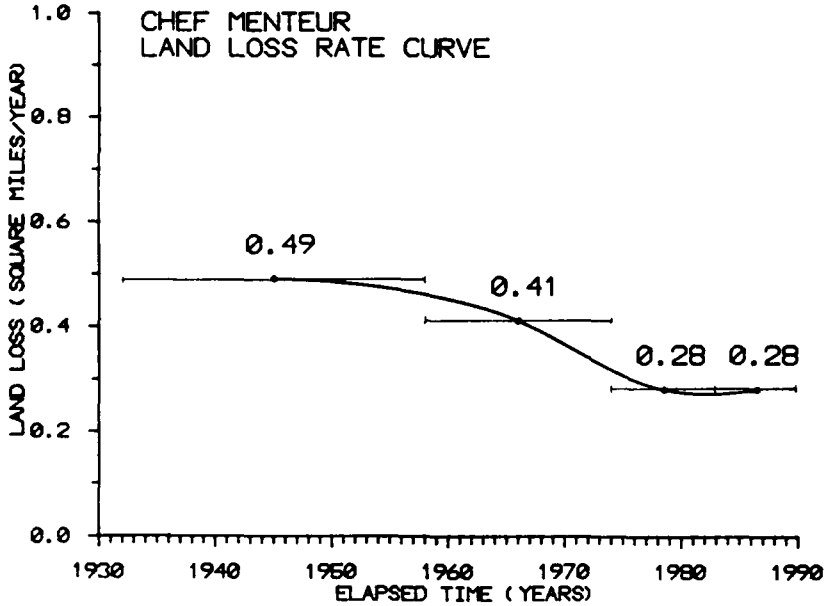

BONNET CARRE
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
1.0
0.8
0.6
0.4
0.2
0.0
0.10
0.44
0.19
0.07
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

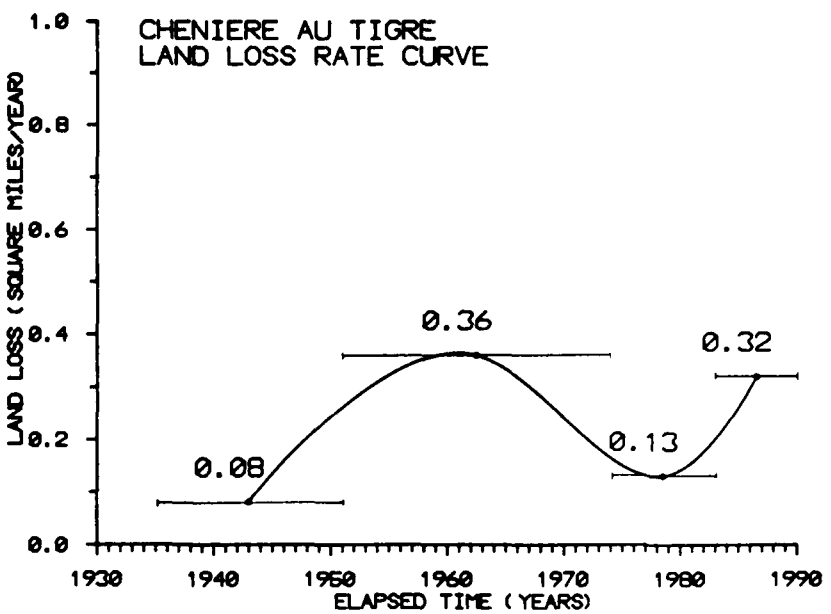

BRETON ISLAND
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
1.0
0.8
0.6
0.4
0.2
0.0
0.26
0.18
0.11
0.05
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

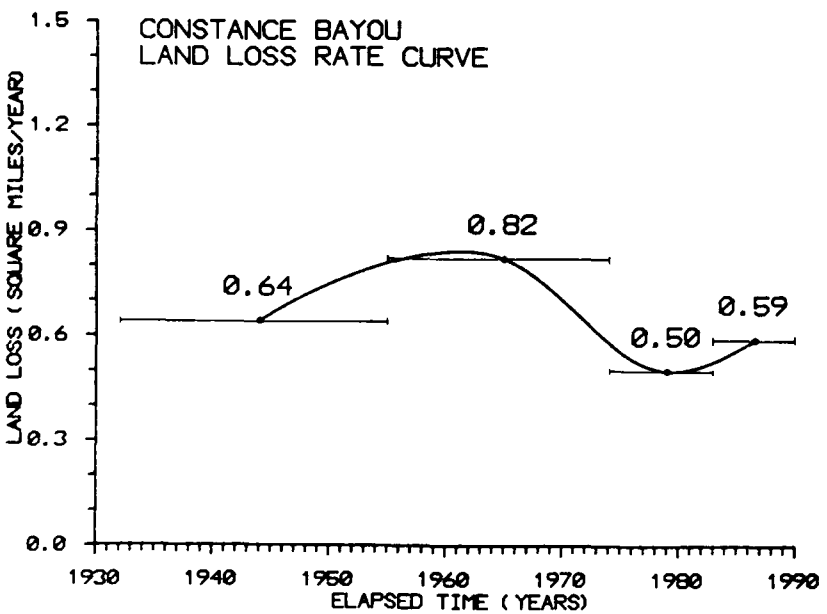

CAILLOU BAY
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
1.0
0.8
0.6
0.4
0.2
0.0
0.22
0.40
0.43
0.21
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

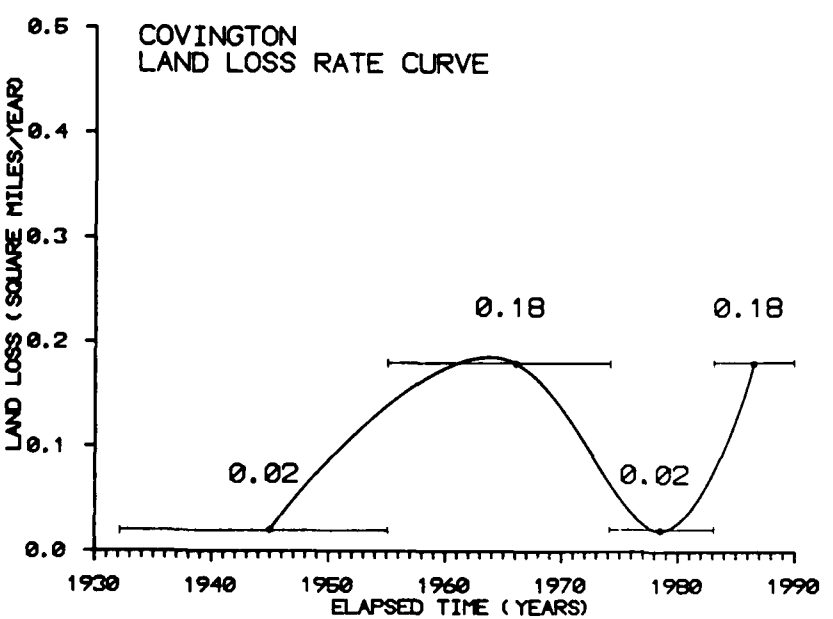

CAMERON
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.08
2.47
0.60
0.25
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

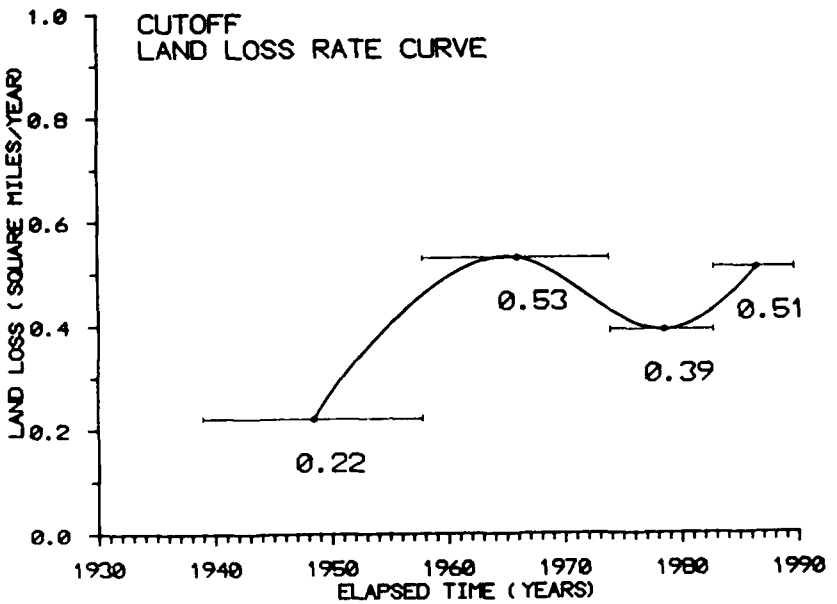

CAT ISLAND
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
0.5
0.4
0.3
0.2
0.1
0.0
0.07
0.09
0.11
0.07
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

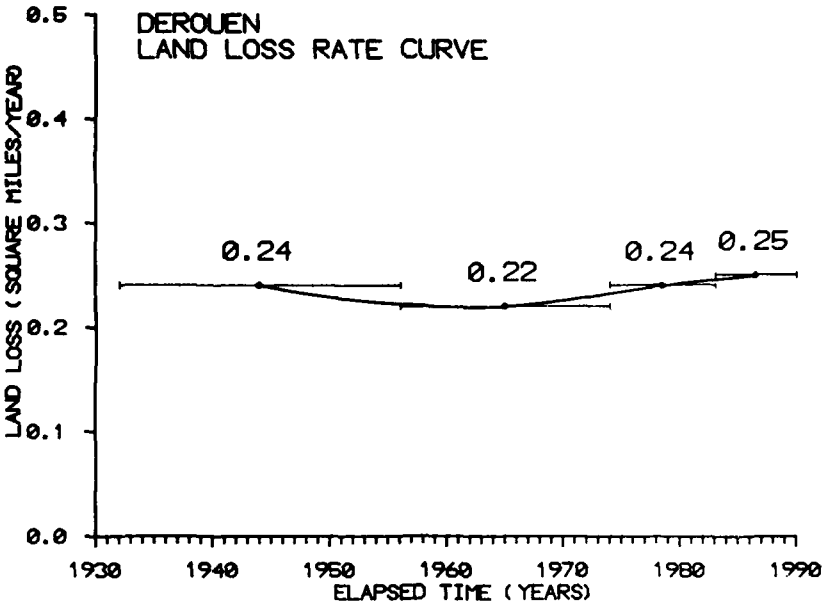

CHEF MENTEUR
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
1.0
0.8
0.6
0.4
0.2
0.0
0.49
0.41
0.28 0.28
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

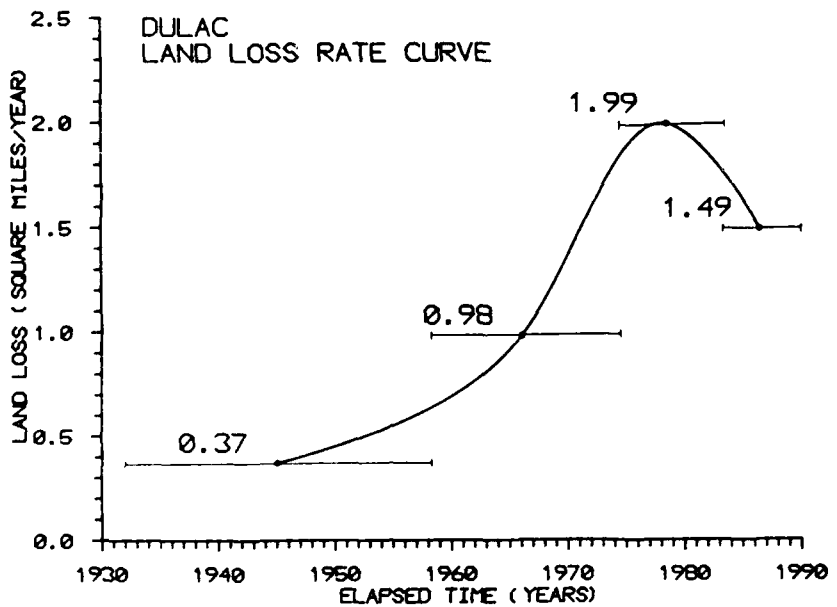

CHENIERE AU TIGRE
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
1.0
0.8
0.6
0.4
0.2
0.0
0.08
0.36
0.13
0.32
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

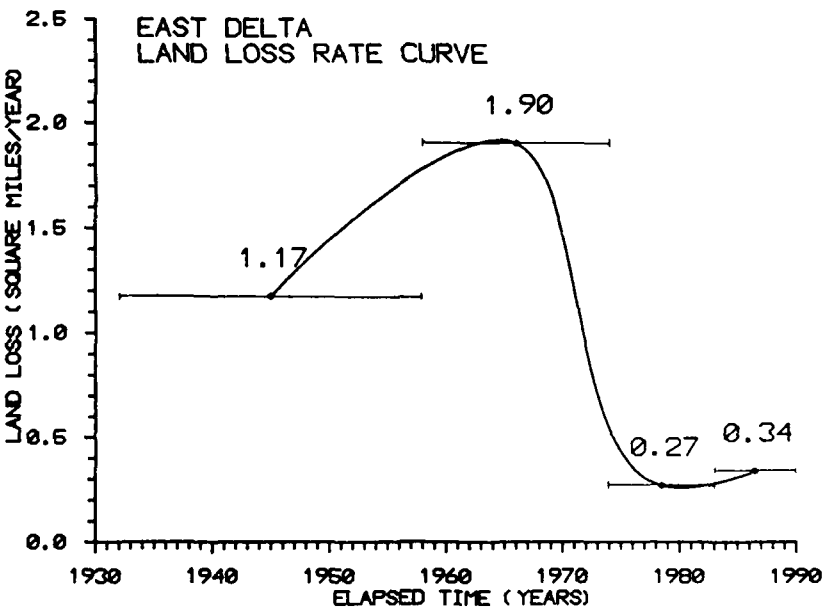

CONSTANCE BAYOU
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
1.5
1.2
0.9
0.6
0.3
0.0
0.64
0.82
0.50
0.59
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

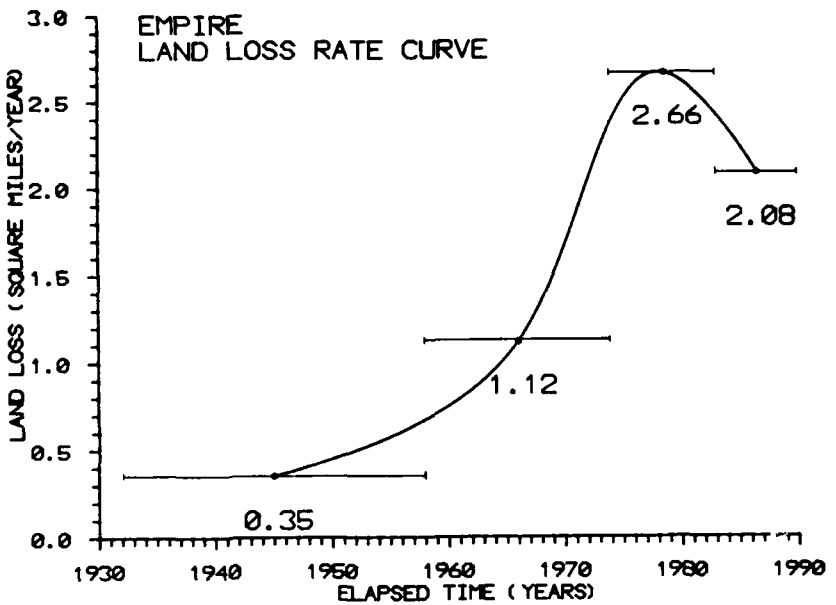

COVINGTON
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
0.5
0.4
0.3
0.2
0.1
0.0
0.02
0.18
0.02
0.18
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

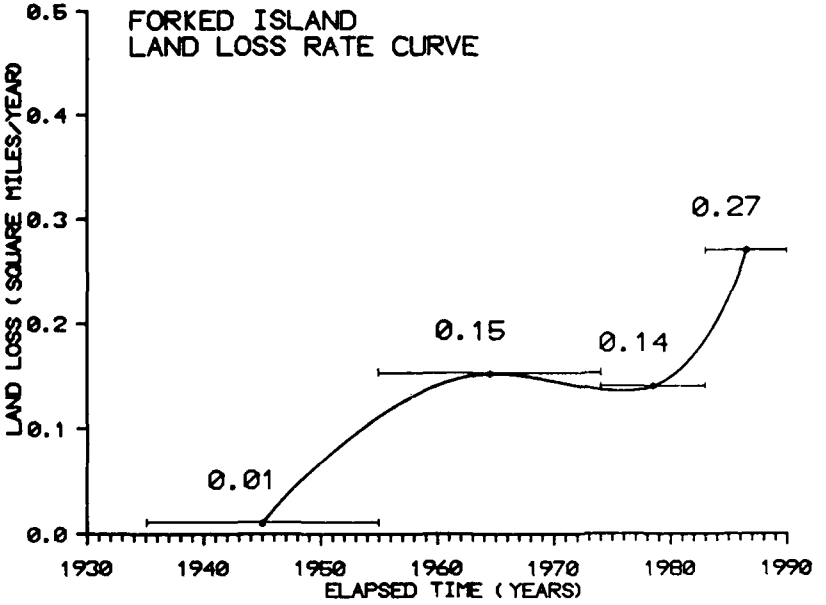

CUTOFF
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
1.0
0.8
0.6
0.4
0.2
0.0
0.22
0.53
0.39
0.51
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

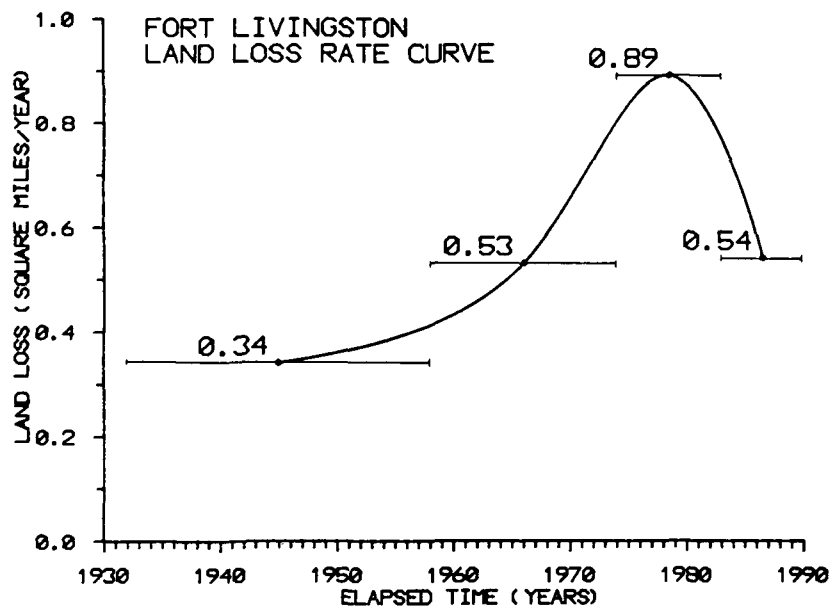

DEROUEN
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
0.5
0.4
0.3
0.2
0.1
0.0
0.24
0.22
0.24
0.25
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

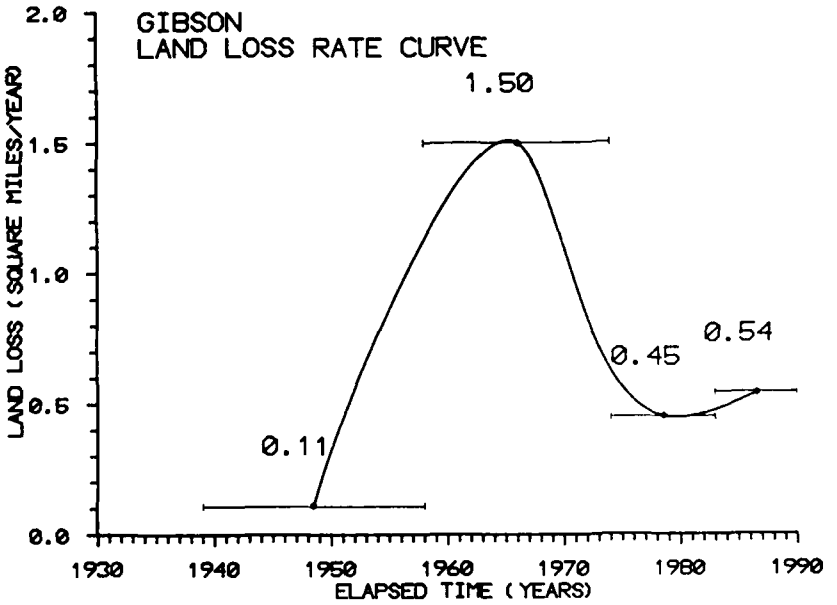

DULAC
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
2.5
2.0
1.5
1.0
0.5
0.0
0.37
0.98
1.99
1.49
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

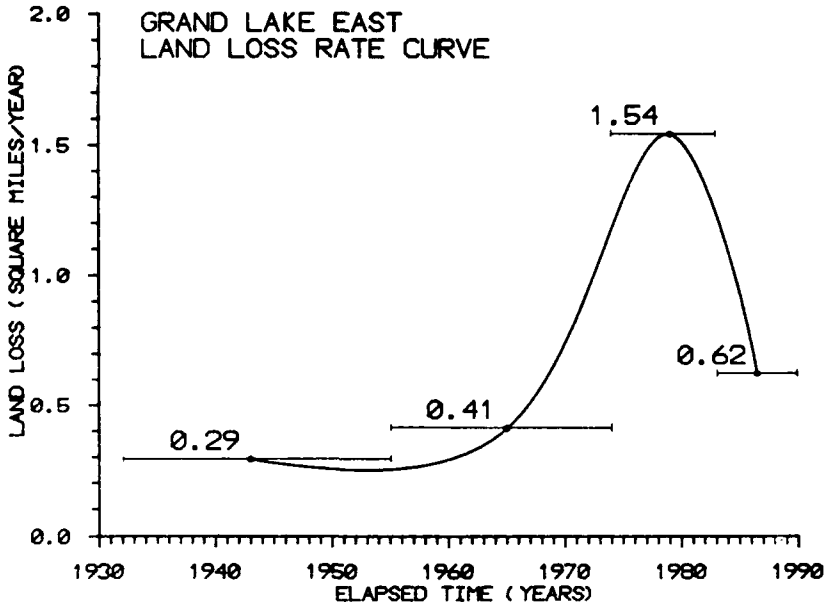

EAST DELTA
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
2.5
2.0
1.5
1.0
0.5
0.0
1.17
1.90
0.27
0.34
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

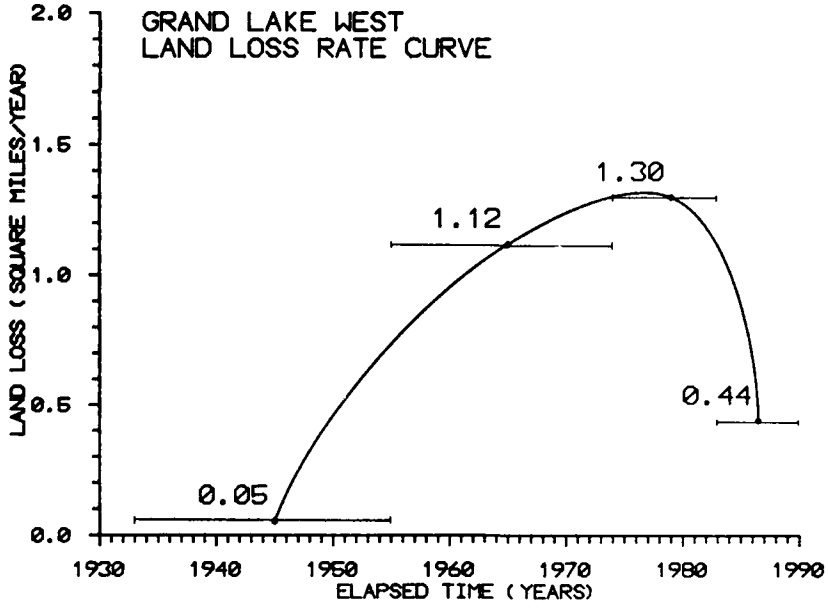

EMPIRE
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
ELAPSED TIME (YEARS)
0.35
1.12
2.66
2.08

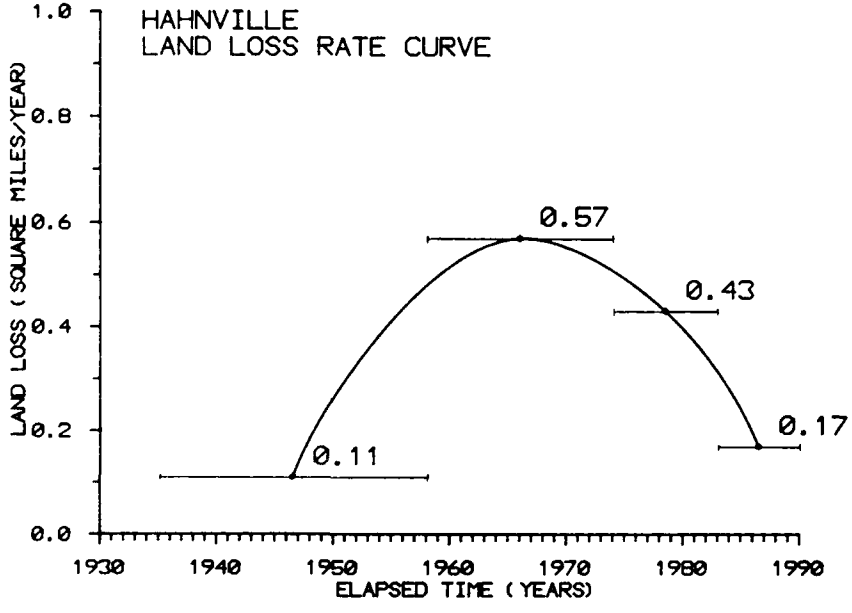

FORKED ISLAND
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
ELAPSED TIME (YEARS)
0.01
0.15
0.14
0.27

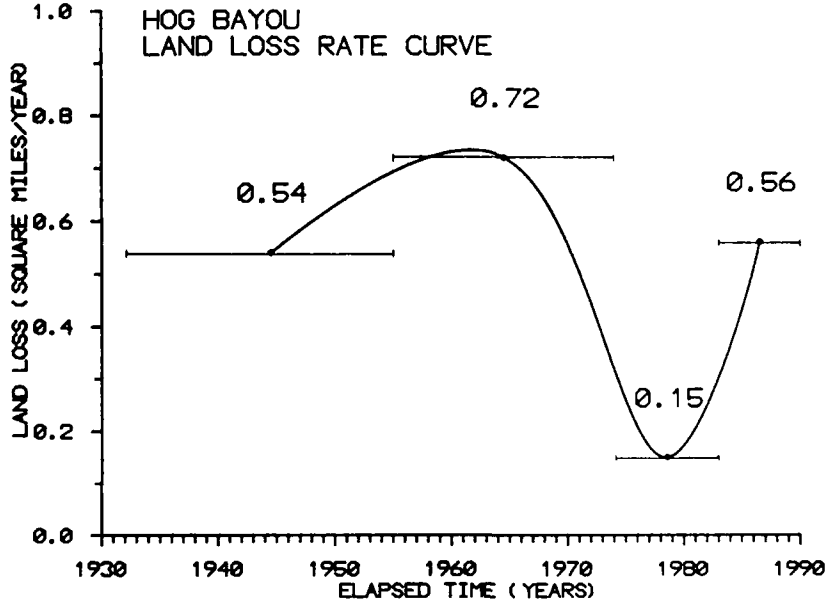

FORT LIVINGSTON
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
ELAPSED TIME (YEARS)
0.34
0.53
0.89
0.54

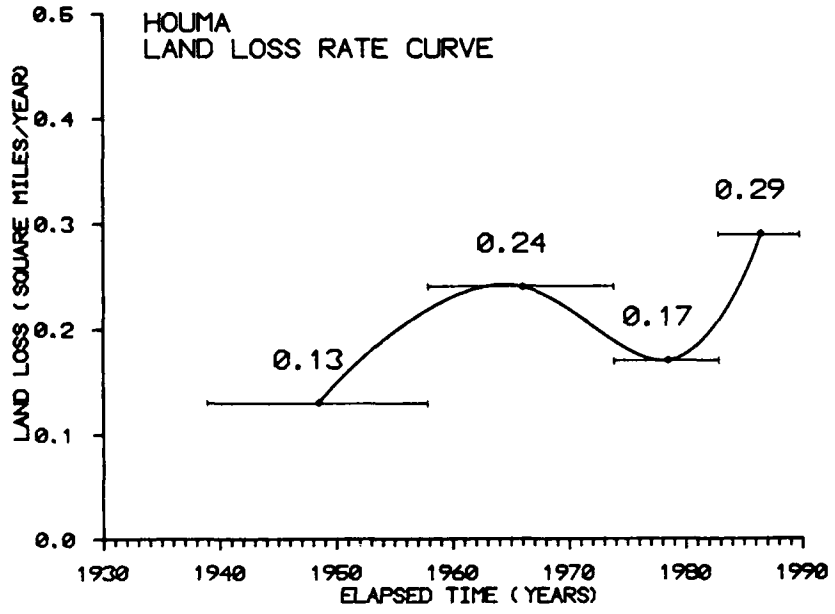

GIBSON
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
ELAPSED TIME (YEARS)
0.11
1.50
0.45
0.54

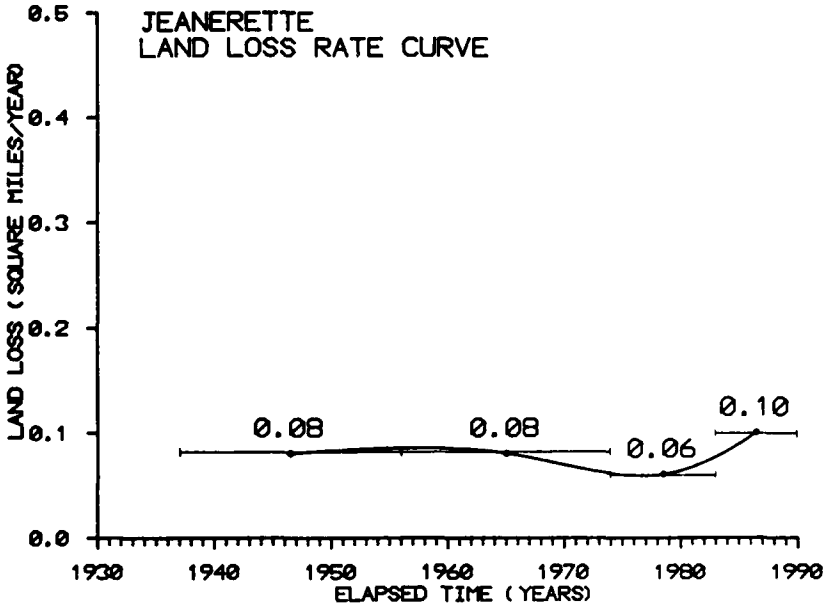

GRAND LAKE EAST
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
2.0
1.5
1.0
0.5
0.0
1.54
0.62
0.41
0.29
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

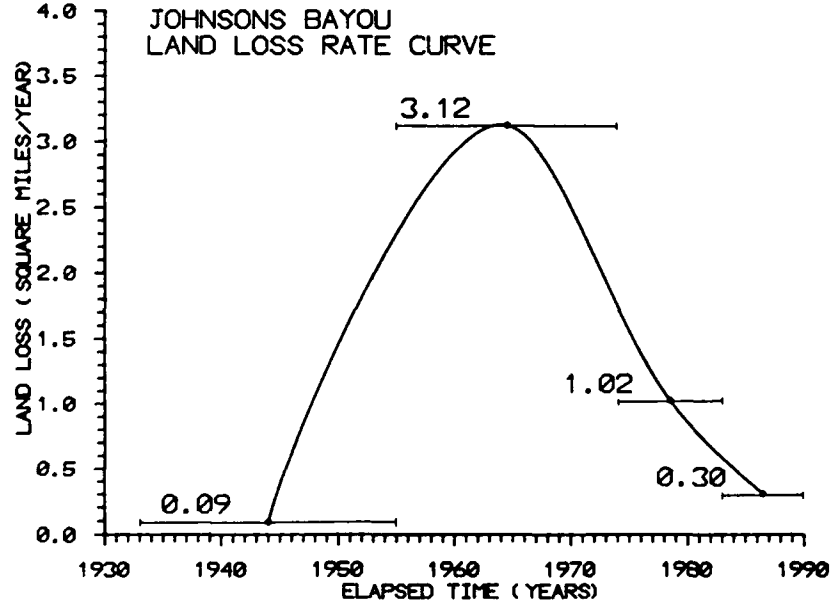

GRAND LAKE WEST
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
2.0
1.5
1.0
0.5
0.0
1.30
1.12
0.44
0.05
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

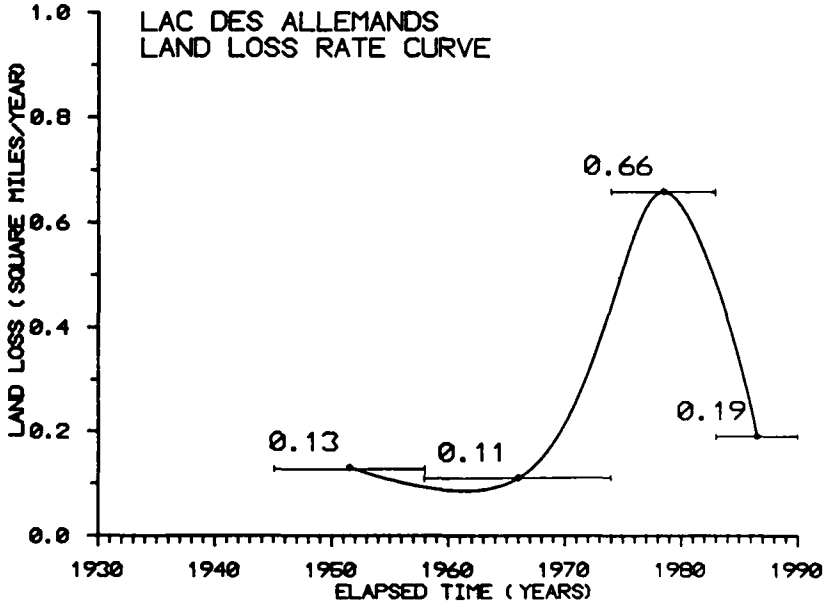

HAHNVILLE
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
1.0
0.8
0.6
0.4
0.2
0.0
0.57
0.43
0.17
0.11
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

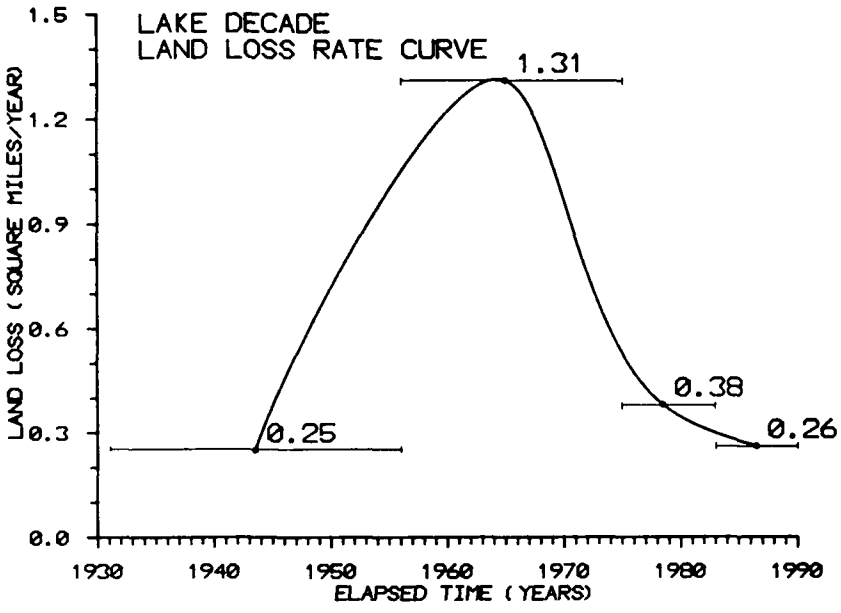

HOG BAYOU
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
1.0
0.8
0.6
0.4
0.2
0.0
0.72
0.56
0.54
0.15
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

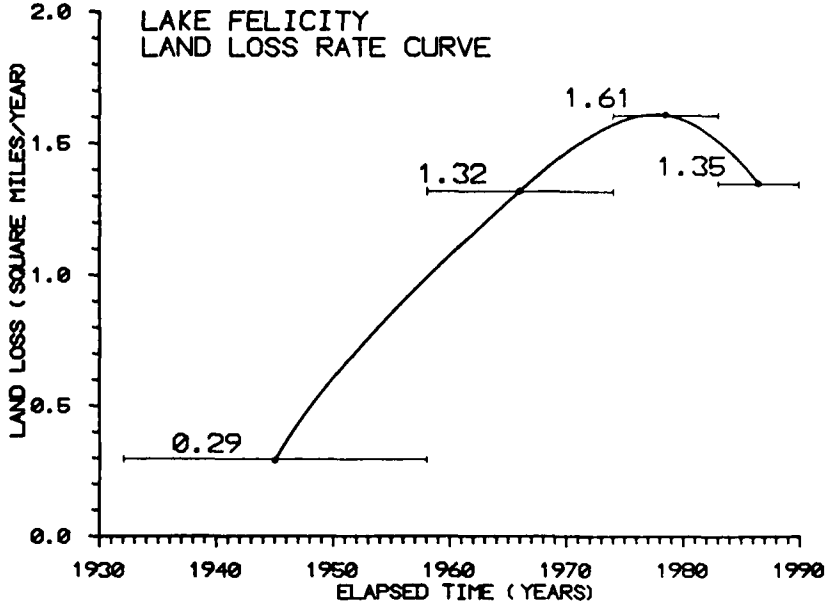

HOUMA
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
ELAPSED TIME (YEARS)
0.13
0.24
0.17
0.29
0.0
0.1
0.2
0.3
0.4
0.5
1930
1940
1950
1960
1970
1980
1990

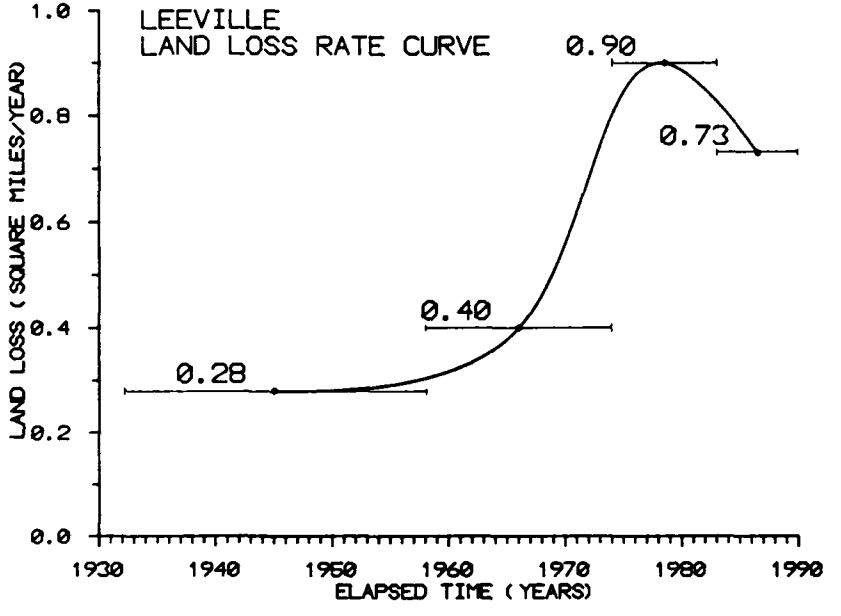

JEANERETTE
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
ELAPSED TIME (YEARS)
0.08
0.08
0.06
0.10
0.0
0.1
0.2
0.3
0.4
0.5
1930
1940
1950
1960
1970
1980
1990

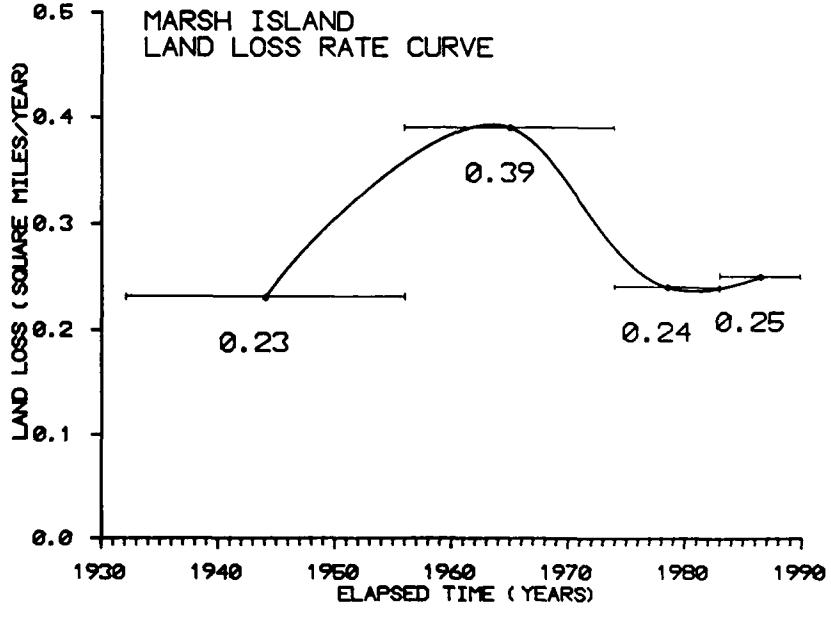

JOHNSONS BAYOU
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
ELAPSED TIME (YEARS)
0.09
3.12
1.02
0.30
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
1930
1940
1950
1960
1970
1980
1990

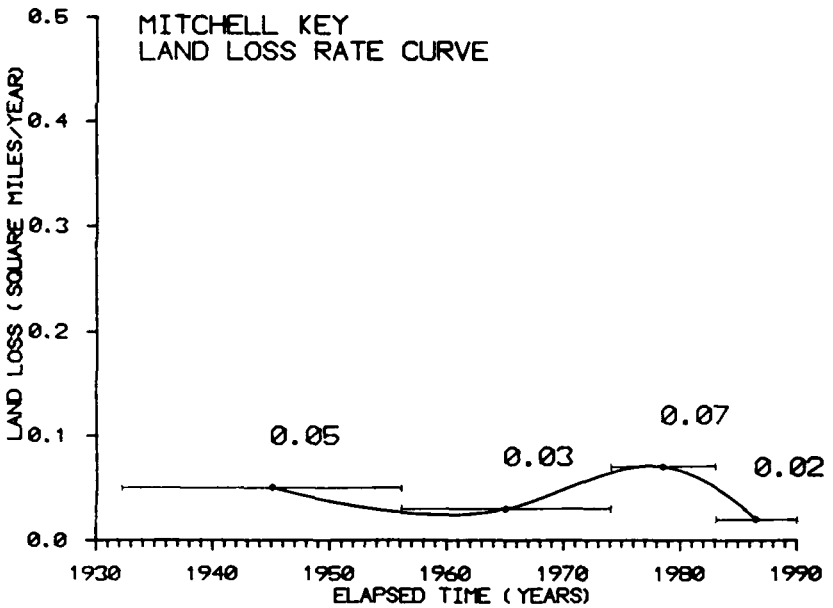

LAC DES ALLEMANDS
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
ELAPSED TIME (YEARS)
0.13
0.11
0.66
0.19
0.0
0.2
0.4
0.6
0.8
1.0
1930
1940
1950
1960
1970
1980
1990

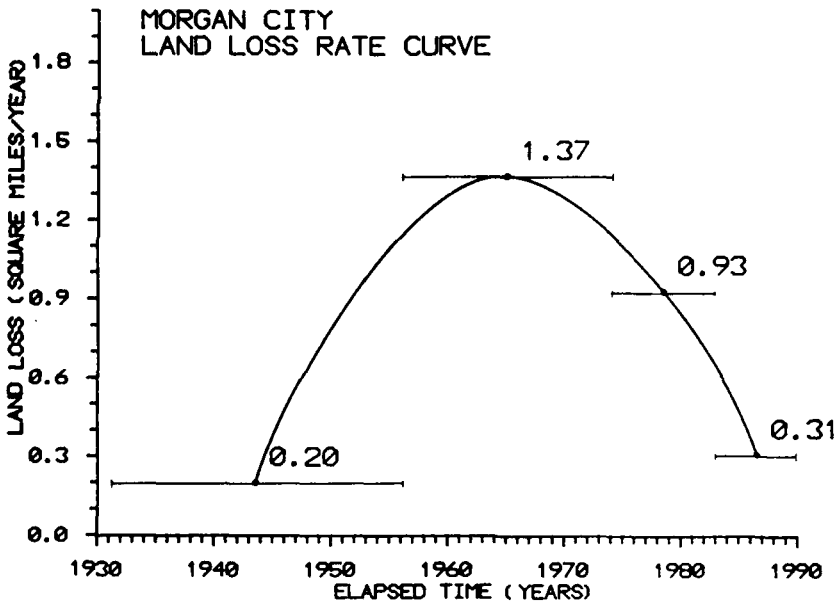

LAKE DECADE
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
ELAPSED TIME (YEARS)
1.5
1.2
0.9
0.6
0.3
0.0
1930
1940
1950
1960
1970
1980
1990
1.31
0.25
0.38
0.26

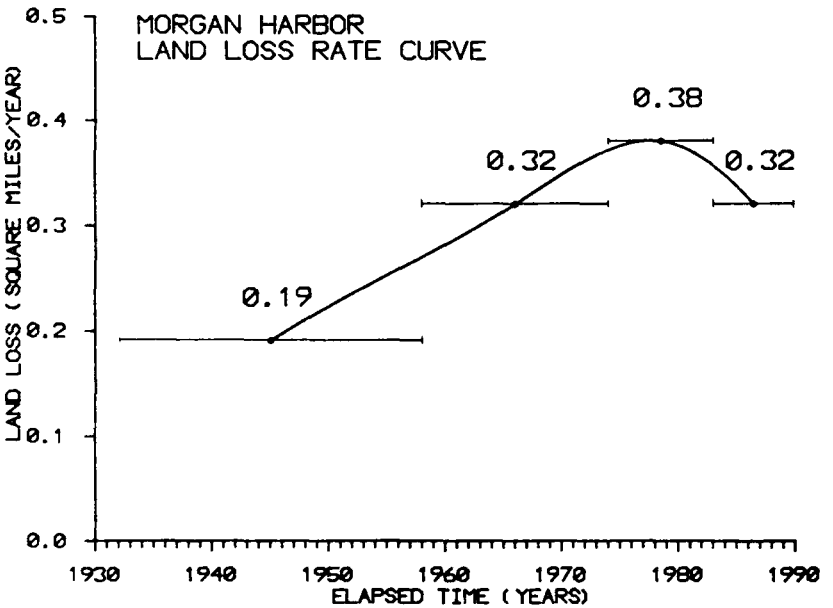

LAKE FELICITY
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
ELAPSED TIME (YEARS)
2.0
1.5
1.0
0.5
0.0
1930
1940
1950
1960
1970
1980
1990
1.61
1.32
1.35
0.29

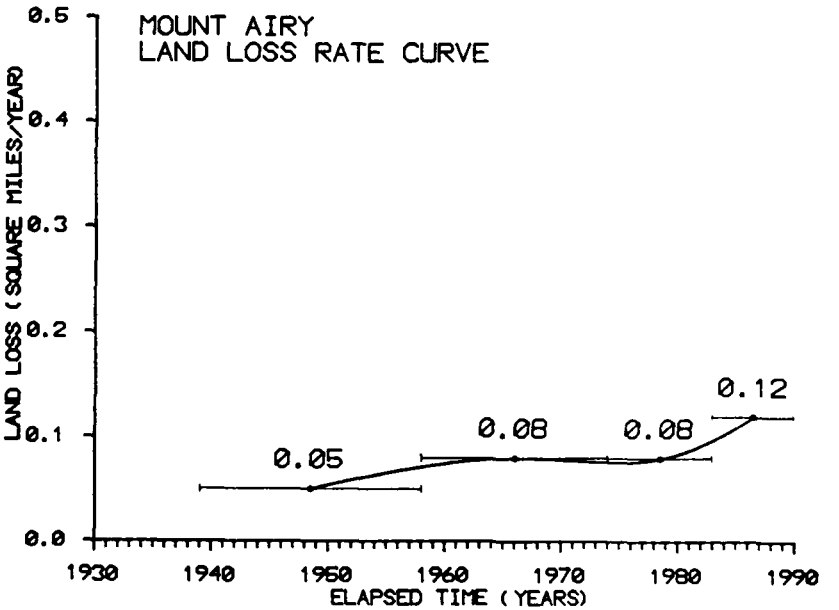

LEEVILLE
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
ELAPSED TIME (YEARS)
1.0
0.8
0.6
0.4
0.2
0.0
1930
1940
1950
1960
1970
1980
1990
0.90
0.73
0.40
0.28

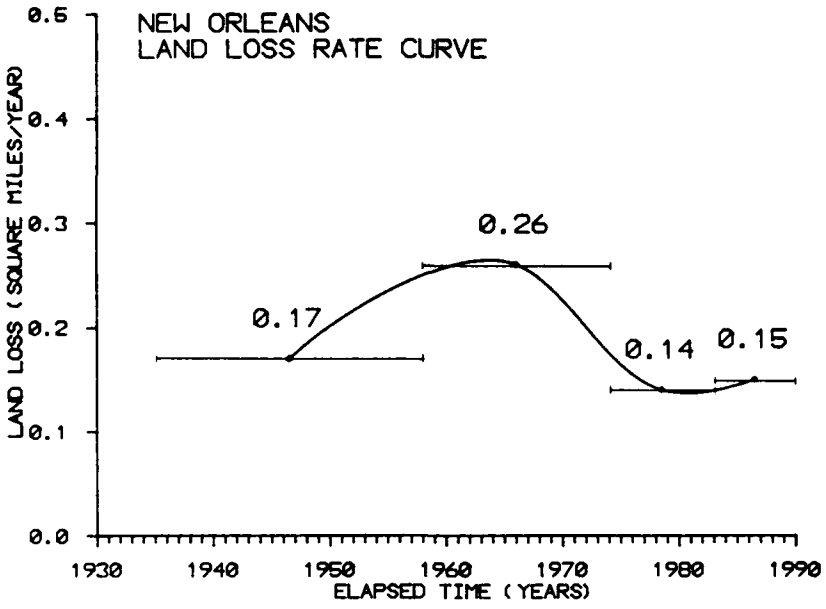

MARSH ISLAND
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
ELAPSED TIME (YEARS)
0.5
0.4
0.3
0.2
0.1
0.0
1930
1940
1950
1960
1970
1980
1990
0.39
0.23
0.24
0.25

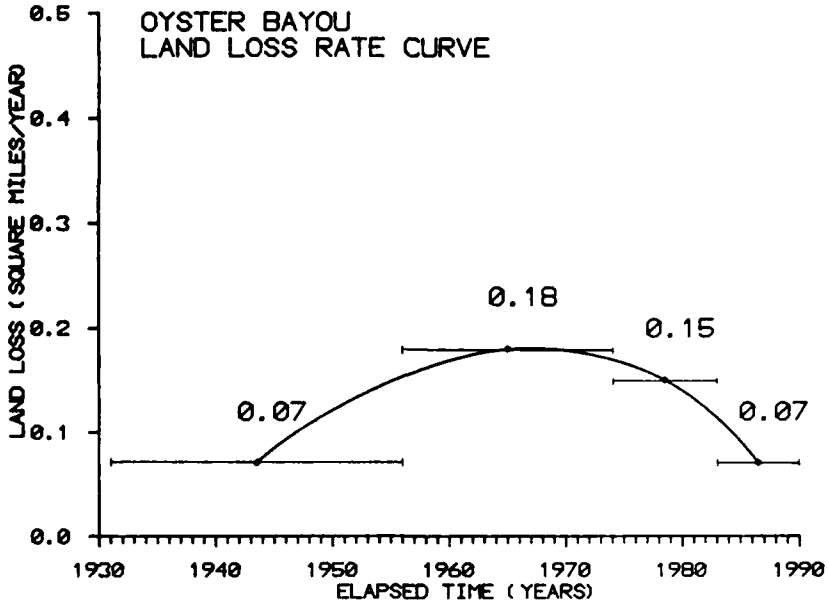

MITCHELL KEY
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
0.5
0.4
0.3
0.2
0.1
0.0
0.05
0.03
0.07
0.02
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

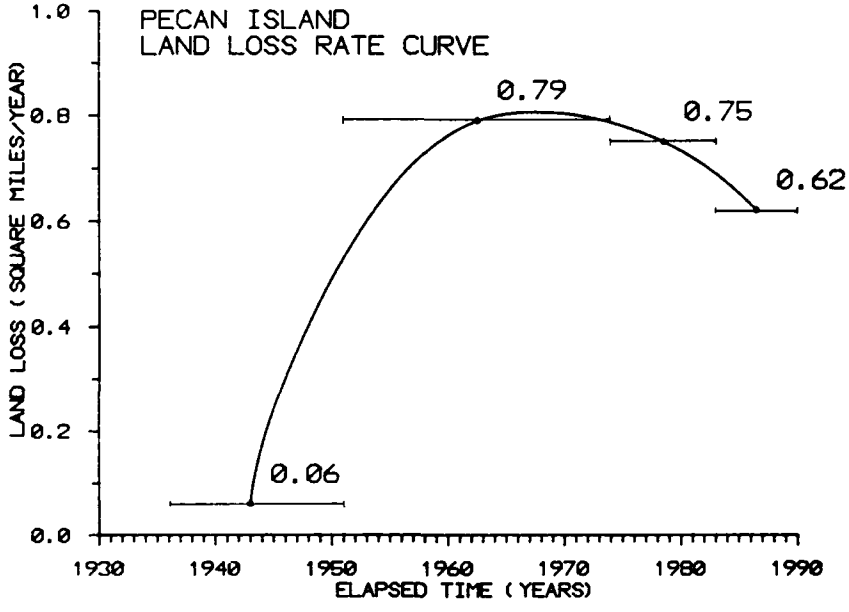

MORGAN CITY
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
1.8
1.5
1.2
0.9
0.6
0.3
0.0
1.37
0.93
0.20
0.31
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

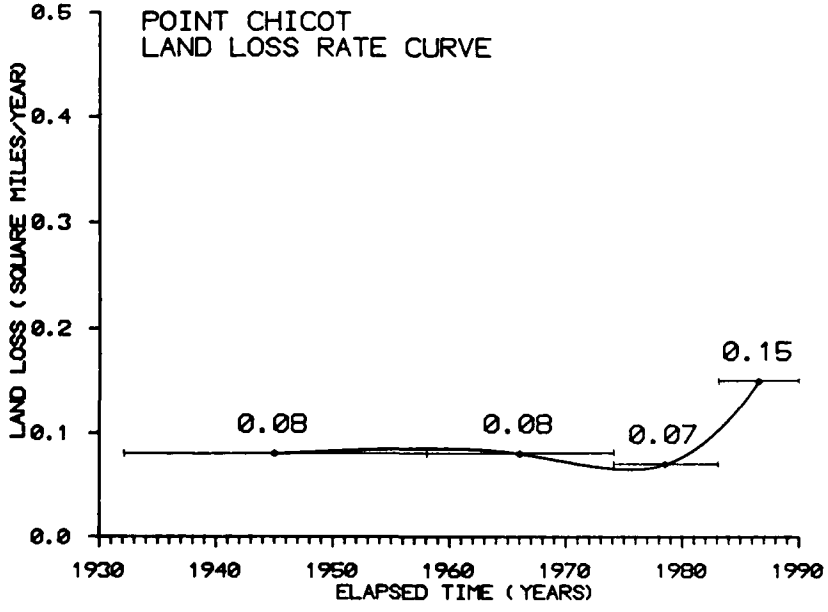

MORGAN HARBOR
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
0.5
0.4
0.3
0.2
0.1
0.0
0.38
0.32
0.32
0.19
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

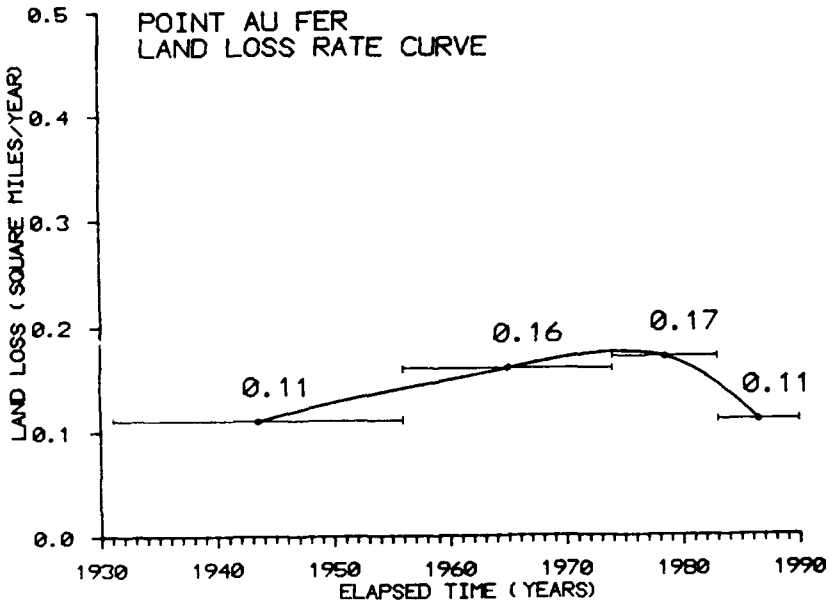

MOUNT AIRY
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
0.5
0.4
0.3
0.2
0.1
0.0
0.12
0.08
0.08
0.05
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

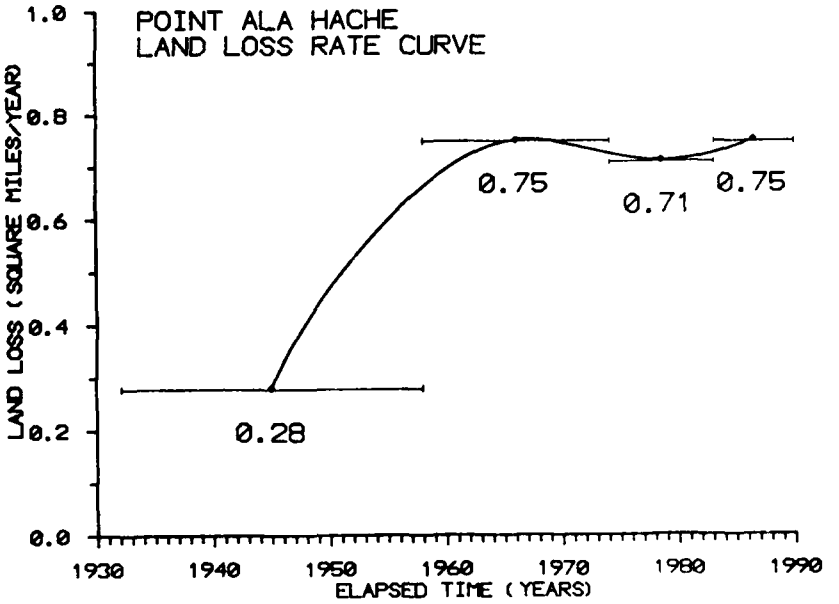

NEW ORLEANS
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
0.0
0.1
0.2
0.3
0.4
0.5
0.17
0.26
0.14
0.15
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

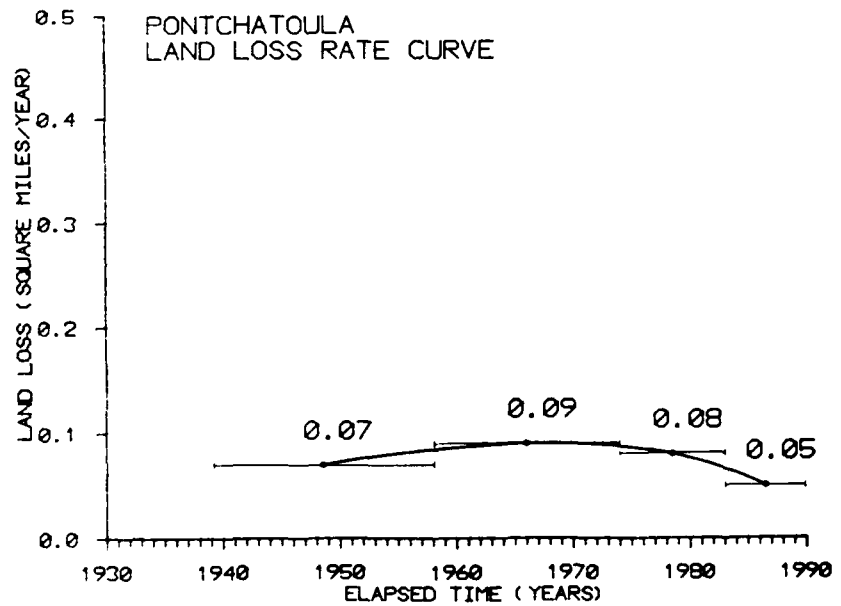

OYSTER BAYOU
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
0.0
0.1
0.2
0.3
0.4
0.5
0.07
0.18
0.15
0.07
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

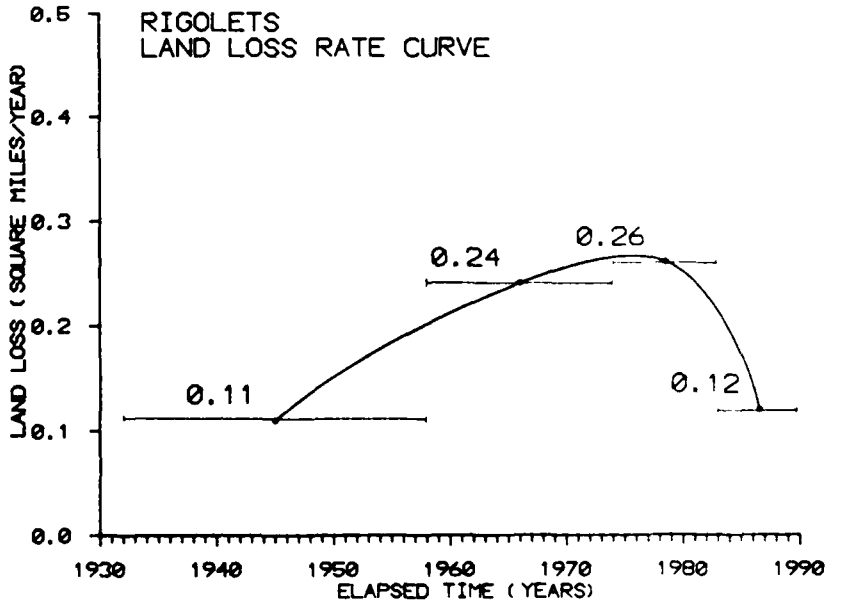

PECAN ISLAND
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
0.0
0.2
0.4
0.6
0.8
1.0
0.06
0.79
0.75
0.62
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

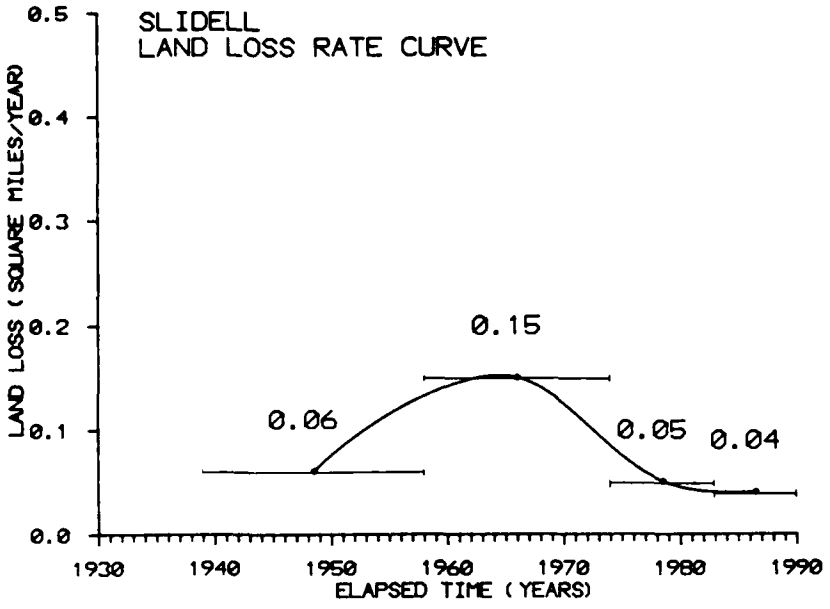

POINT CHICOT
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
0.0
0.1
0.2
0.3
0.4
0.5
0.08
0.08
0.07
0.15
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

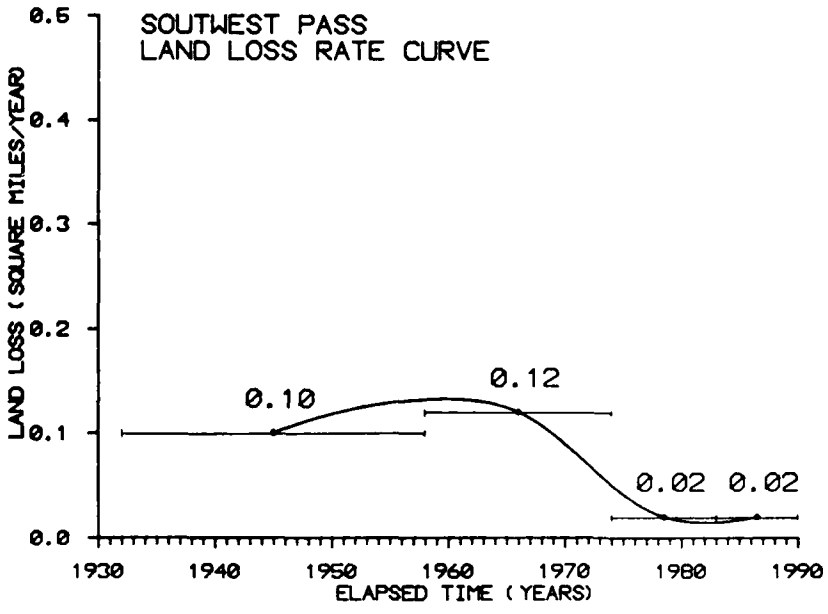

POINT AU FER
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
0.5
0.4
0.3
0.2
0.1
0.0
0.11
0.16
0.17
0.11
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

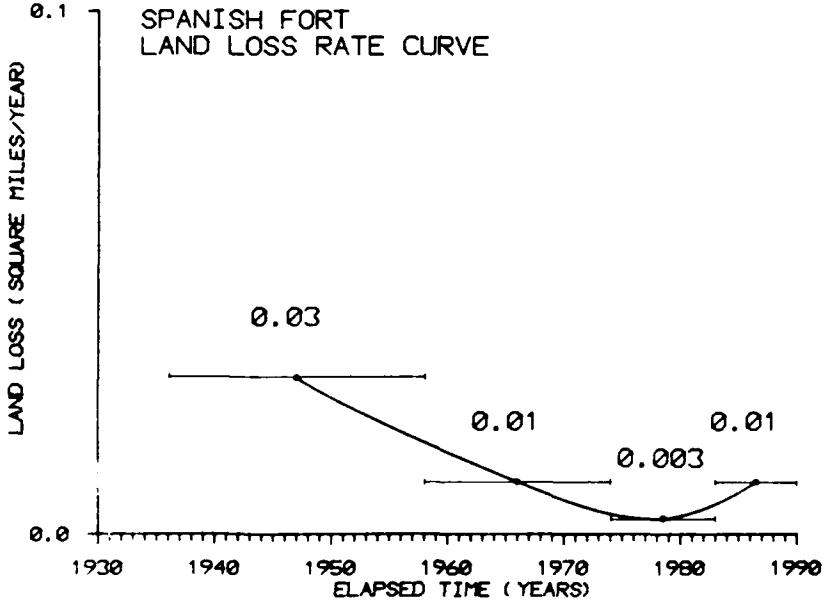

POINT ALA HACHE
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
1.0
0.8
0.6
0.4
0.2
0.0
0.28
0.75
0.71
0.75
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

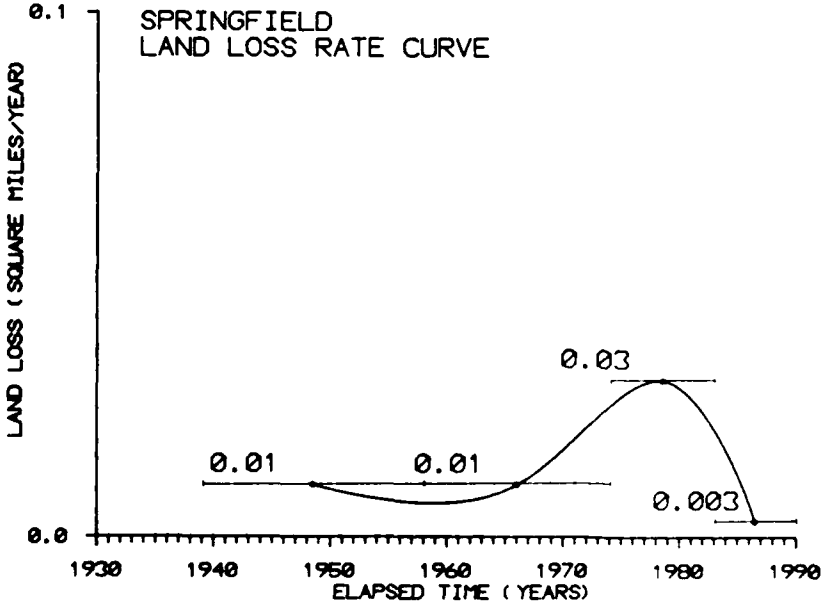

PONTCHATOULA
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
0.5
0.4
0.3
0.2
0.1
0.0
0.07
0.09
0.08
0.05
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

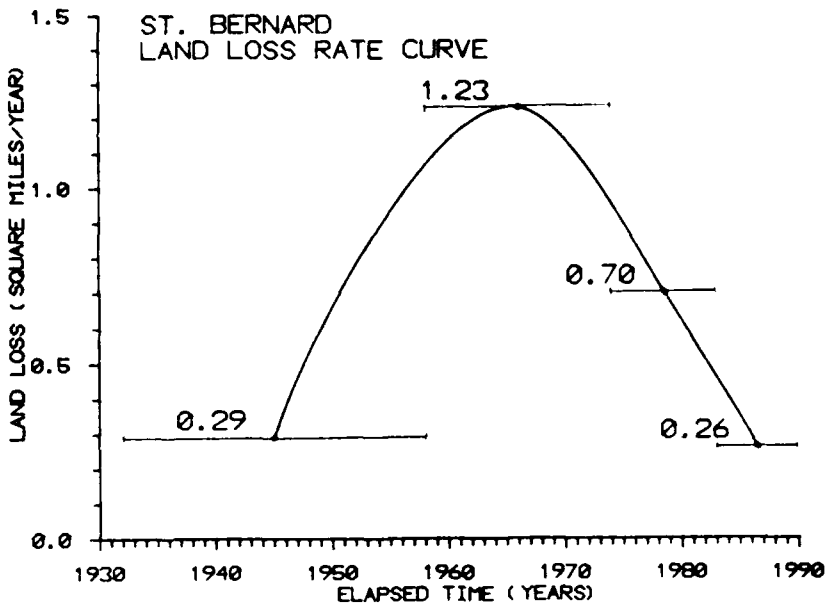

RIGOLETS
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
0.5
0.4
0.3
0.2
0.1
0.0
0.11
0.24
0.26
0.12
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

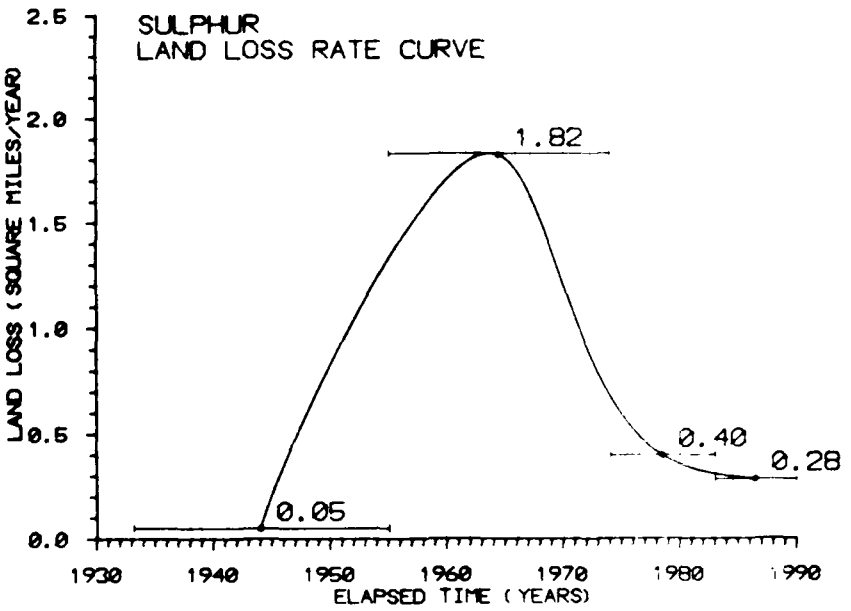

SLIDELL
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
0.5
0.4
0.3
0.2
0.1
0.0
0.06
0.15
0.05
0.04
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

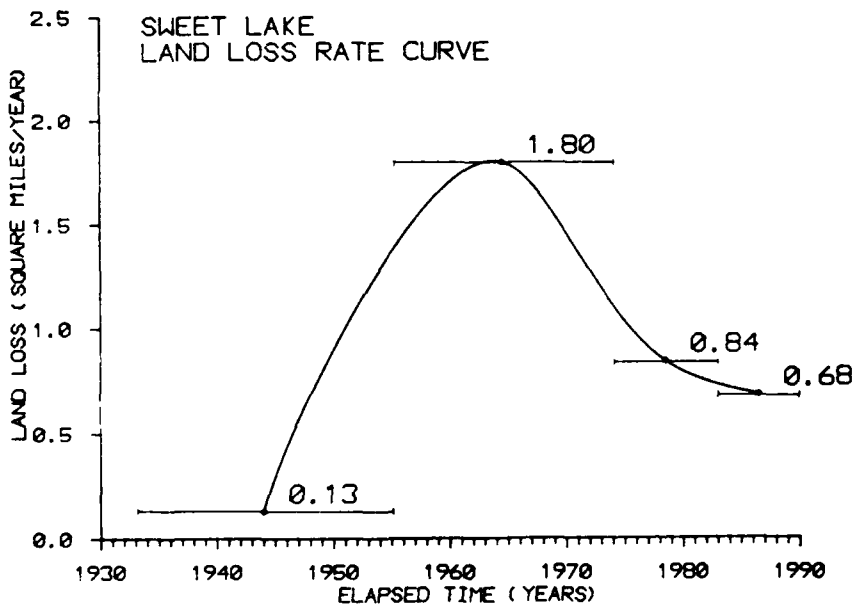

SOUTHWEST PASS
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
0.5
0.4
0.3
0.2
0.1
0.0
0.10
0.12
0.02
0.02
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

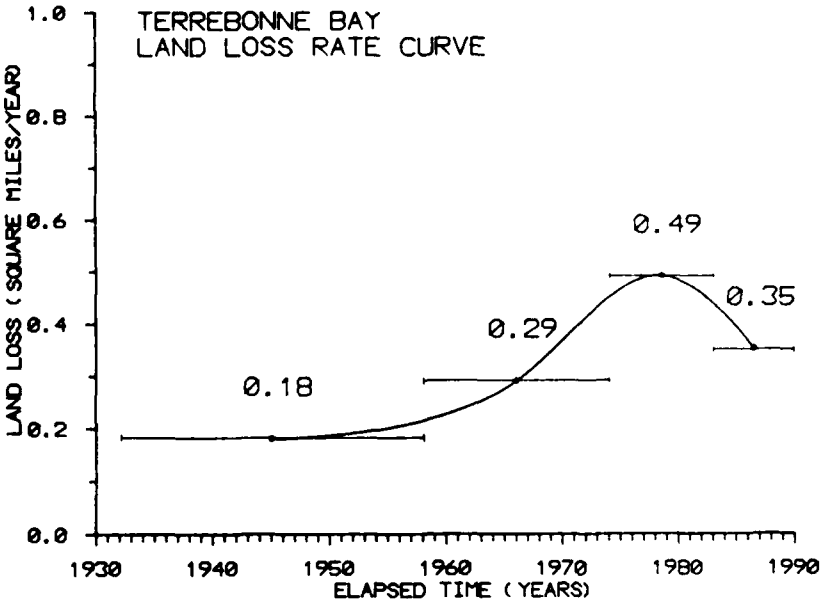

SPANISH FORT
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
0.1
0.0
0.03
0.01
0.003
0.01
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

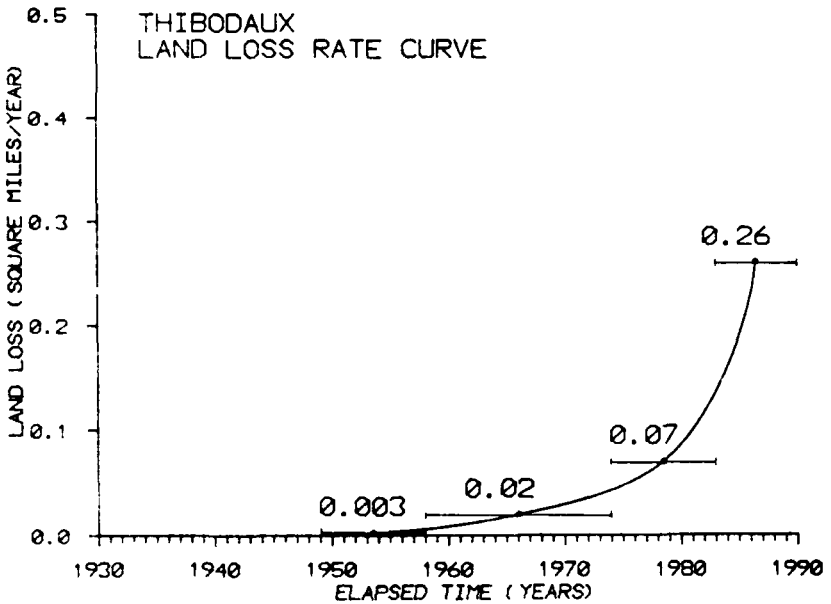

SPRINGFIELD
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
0.1
0.0
0.01
0.01
0.03
0.003
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

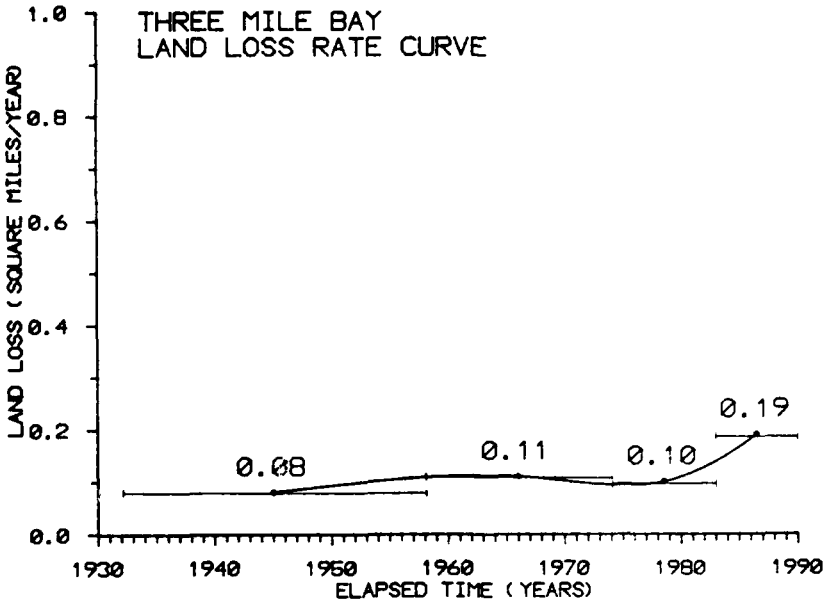

ST. BERNARD
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
1.5
1.0
0.5
0.0
1.23
0.70
0.29
0.26
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

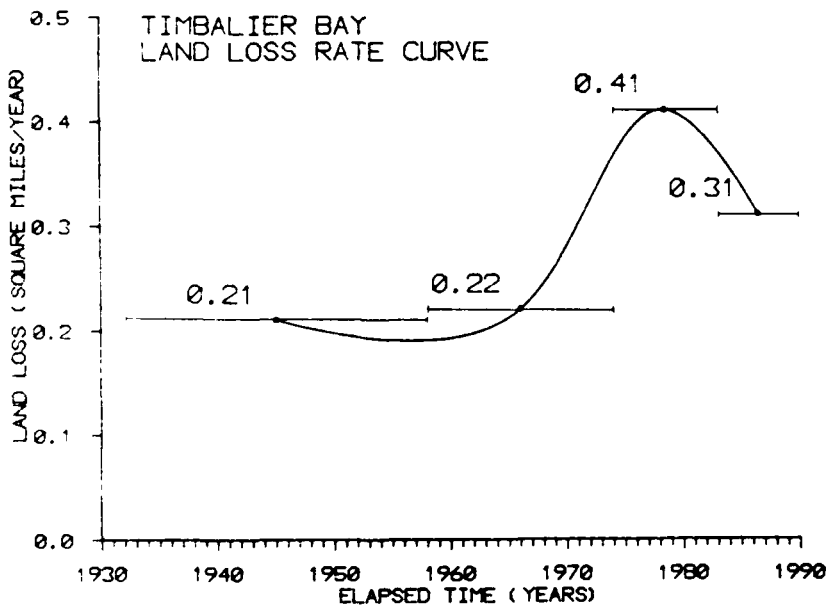

SULPHUR
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
2.5
2.0
1.5
1.0
0.5
0.0
1.82
0.40
0.28
0.05
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

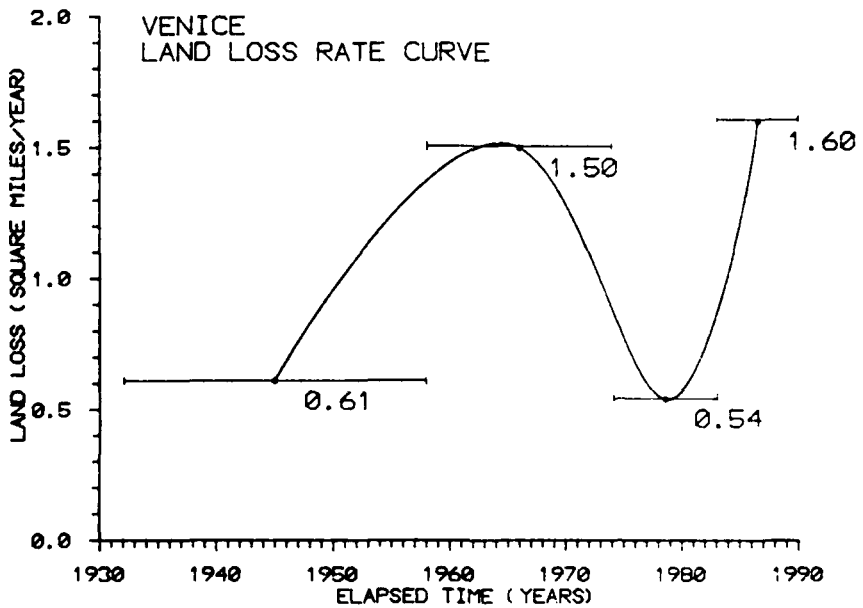

SWEET LAKE
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
2.5
2.0
1.5
1.0
0.5
0.0
1.80
0.84
0.68
0.13
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

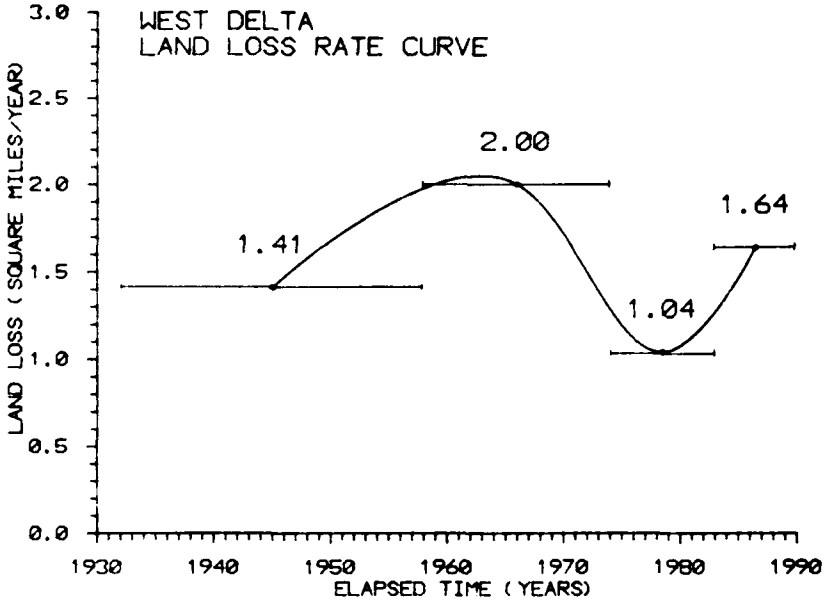

TERREBONNE BAY
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
1.0
0.8
0.6
0.4
0.2
0.0
0.49
0.35
0.29
0.18
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

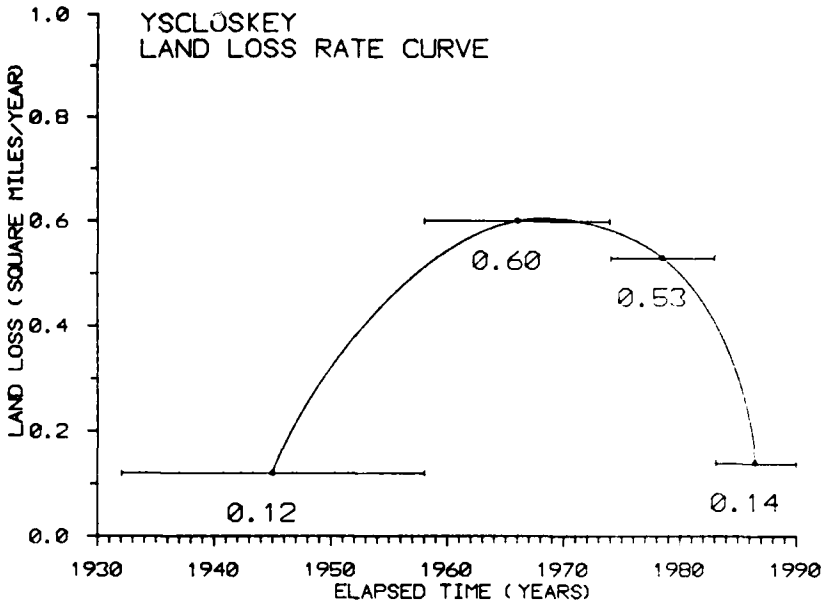

THIBODAUX
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
0.0
0.1
0.2
0.3
0.4
0.5
0.003
0.02
0.07
0.26
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)


THREE MILE BAY
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
0.0
0.2
0.4
0.6
0.8
1.0
0.08
0.11
0.10
0.19
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

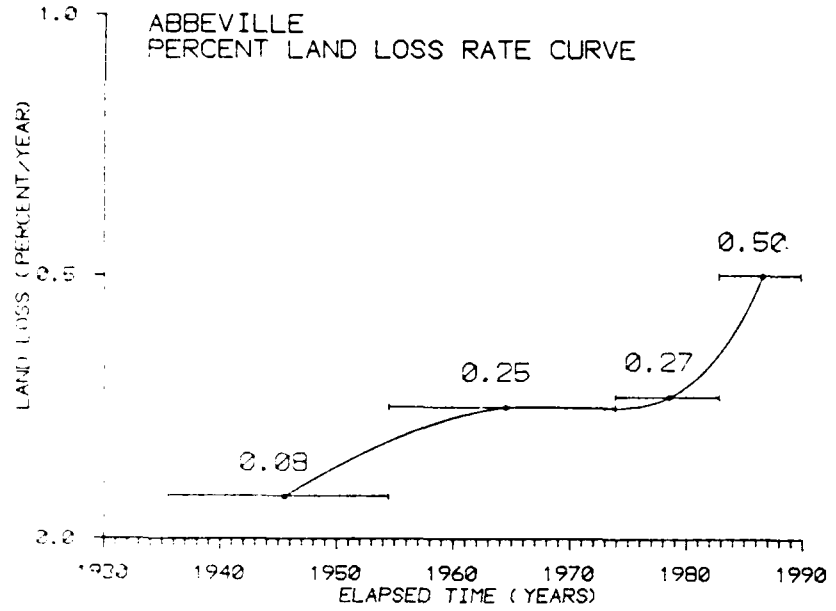

TIMBALIER BAY
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
0.0
0.1
0.2
0.3
0.4
0.5
0.21
0.22
0.41
0.31
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

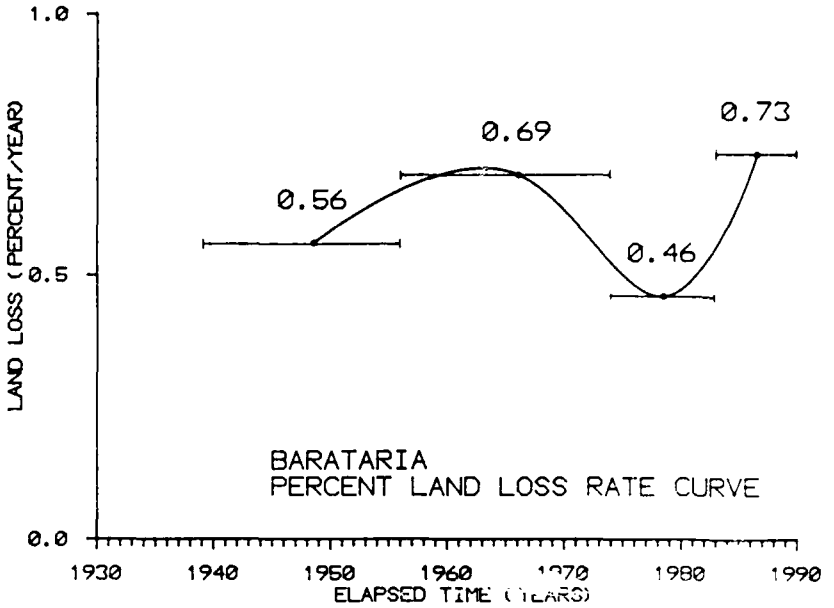

VENICE
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
0.0
0.5
1.0
1.5
2.0
0.61
1.50
0.54
1.60
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

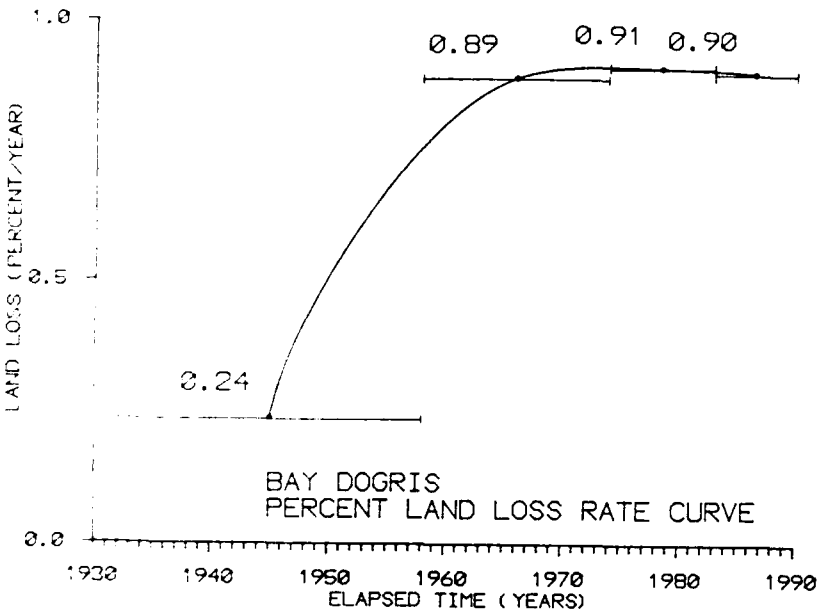

WEST DELTA
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1.41
2.00
1.04
1.64
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

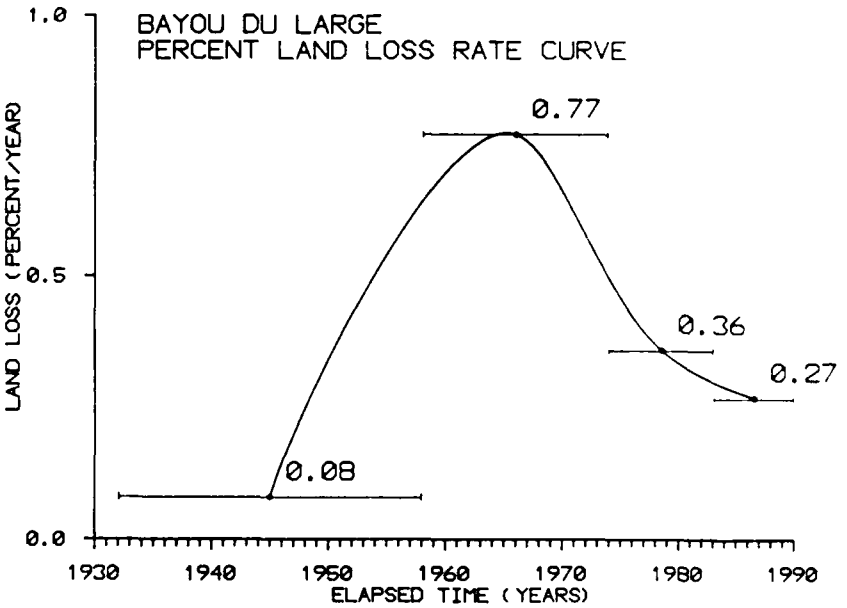

YSCLOSKEY
LAND LOSS RATE CURVE
LAND LOSS (SQUARE MILES/YEAR)
1.0
0.8
0.6
0.4
0.2
0.0
0.12
0.60
0.53
0.14
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

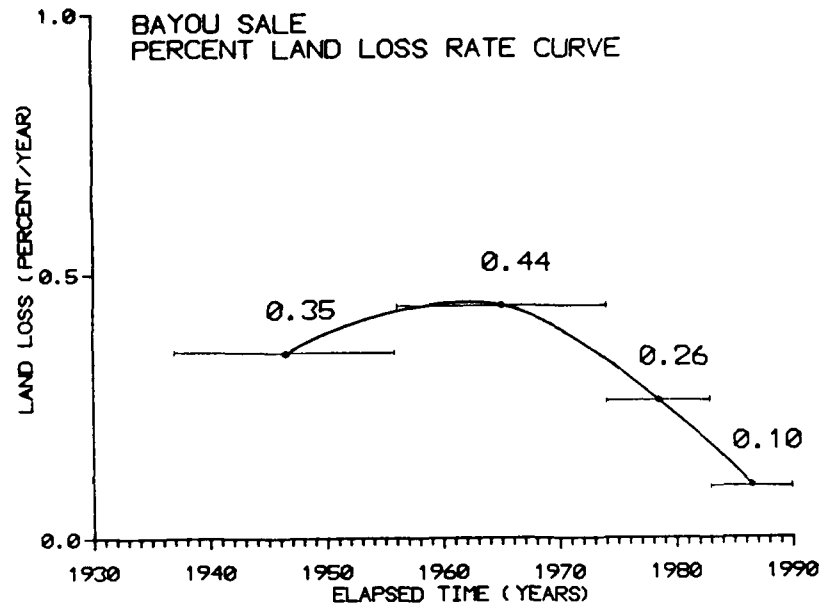
APPENDIX B: PERCENT LAND LOSS RATE CURVES

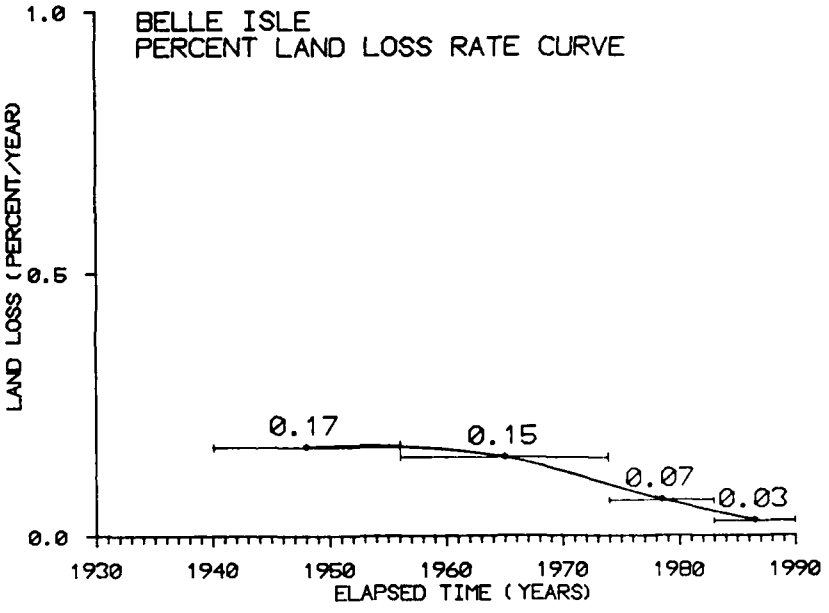

ABBEVILLE
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.08
0.25
0.27
0.50
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

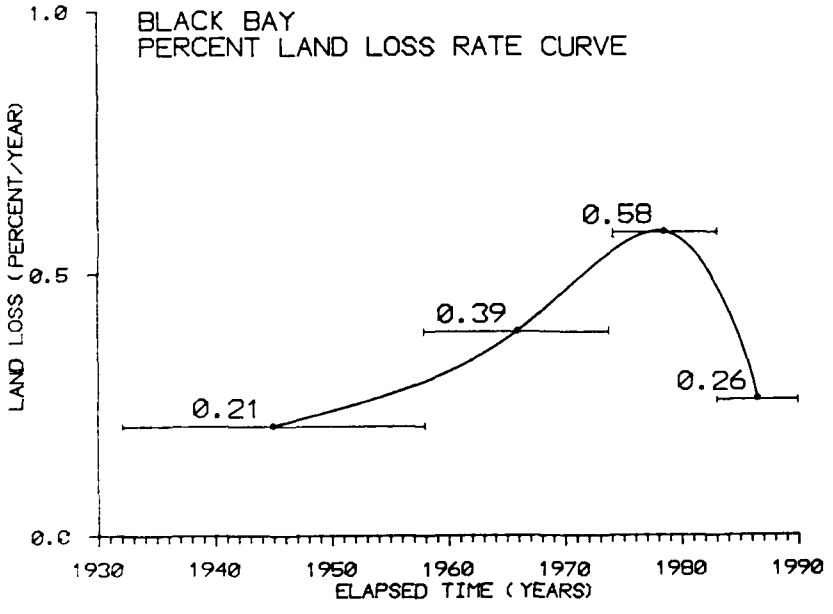

1.0
0.5
0.0
LAND LOSS (PERCENT/YEAR)
0.56
0.69
0.46
0.73
BARATARIA
PERCENT LAND LOSS RATE CURVE
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

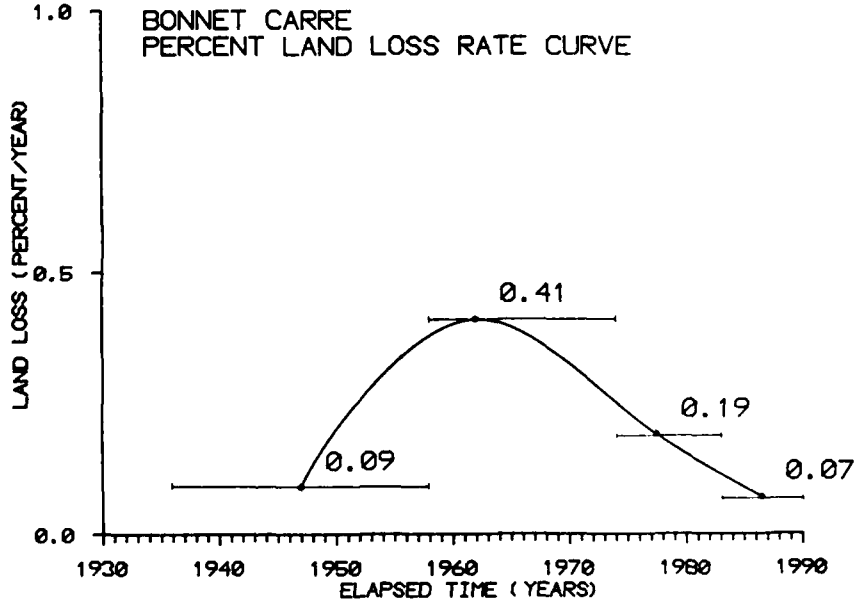

1.0
0.5
0.0
LAND LOSS (PERCENT/YEAR)
0.24
0.89
0.91
0.90
BAY DOGRIS
PERCENT LAND LOSS RATE CURVE
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

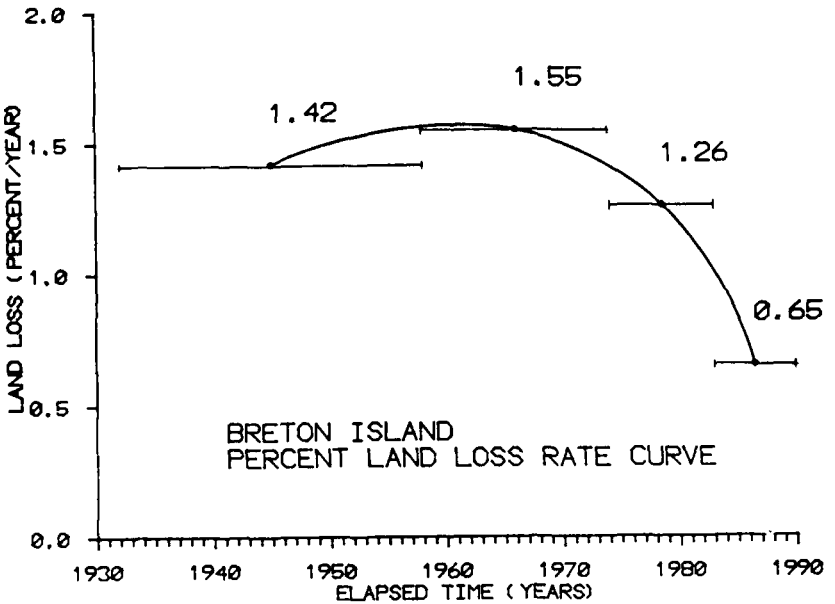

1.0
0.5
0.0
LAND LOSS (PERCENT/YEAR)
BAYOU DU LARGE
PERCENT LAND LOSS RATE CURVE
0.08
0.77
0.36
0.27
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

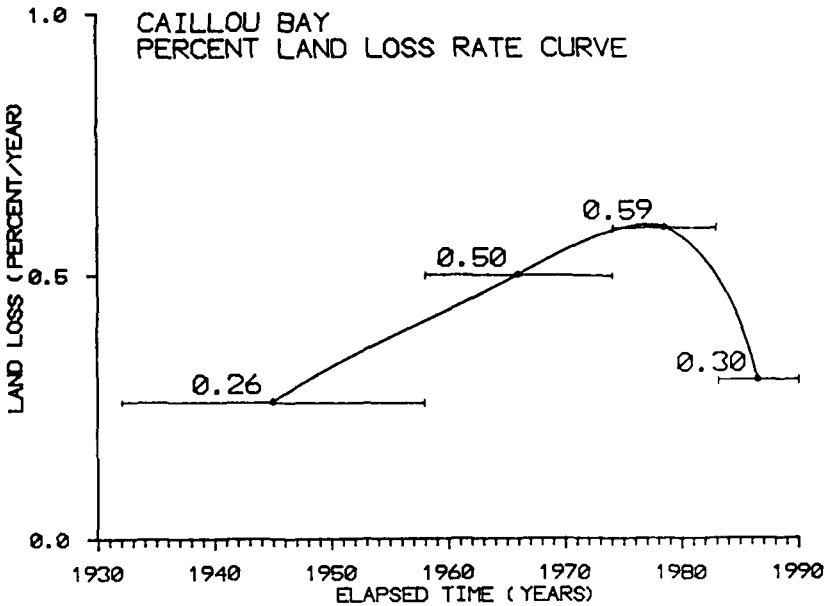

BAYOU SALE
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.35
0.44
0.26
0.10
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

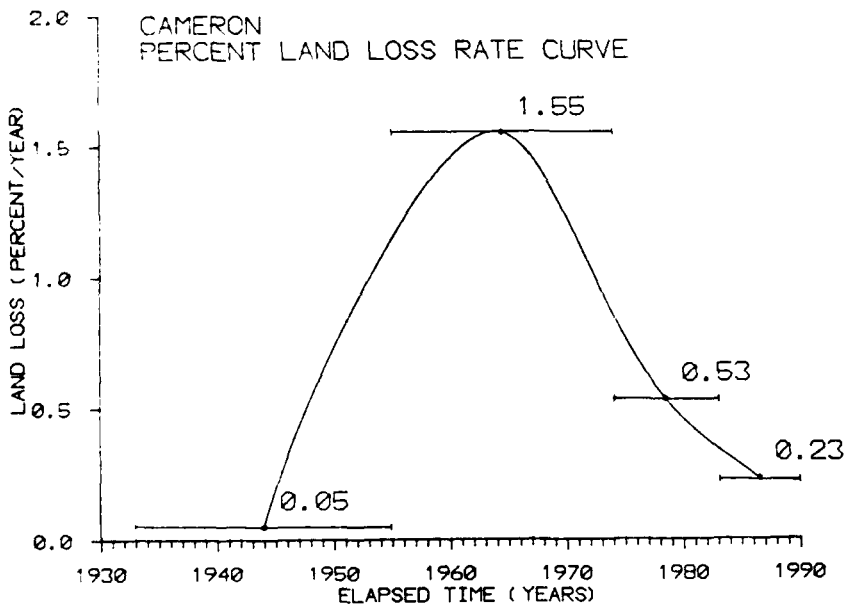

BELLE ISLE
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.17
0.15
0.07
0.03
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

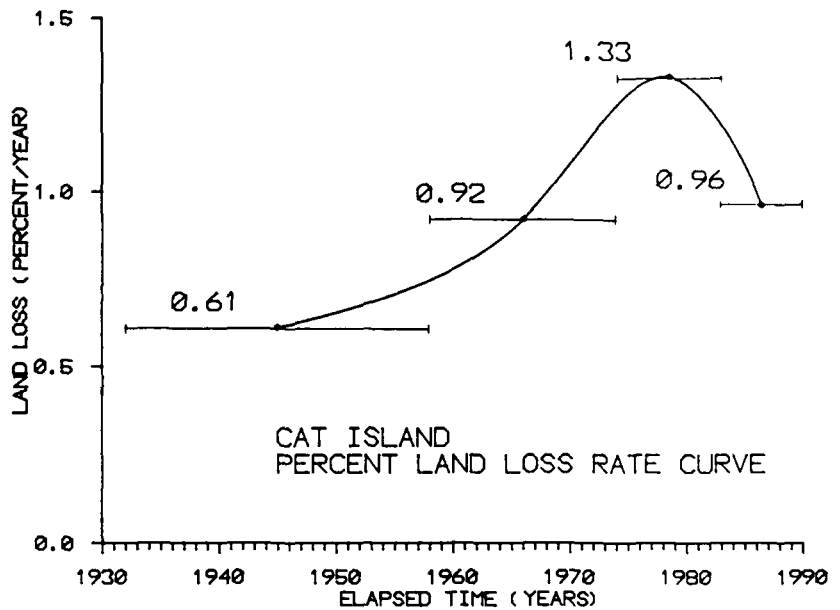

BLACK BAY
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.21
0.39
0.58
0.26
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

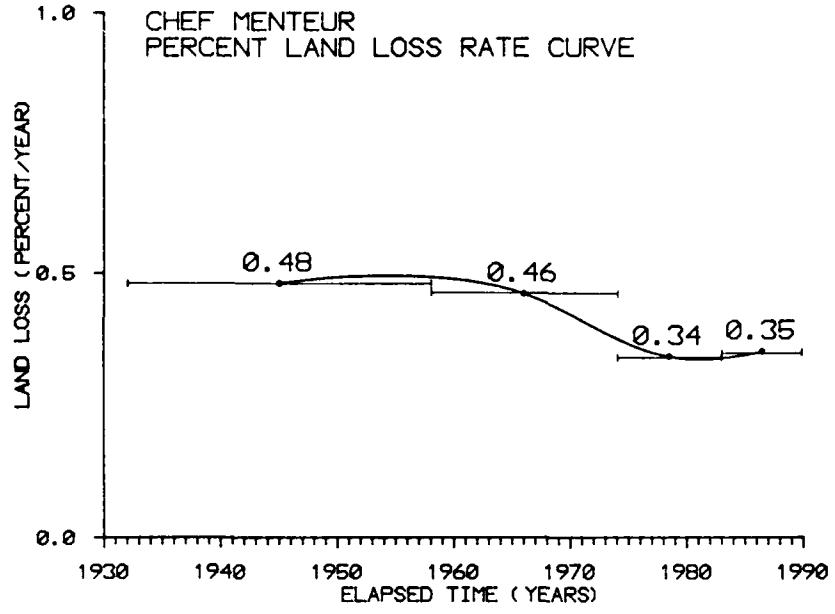

BONNET CARRE
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.09
0.41
0.19
0.07
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

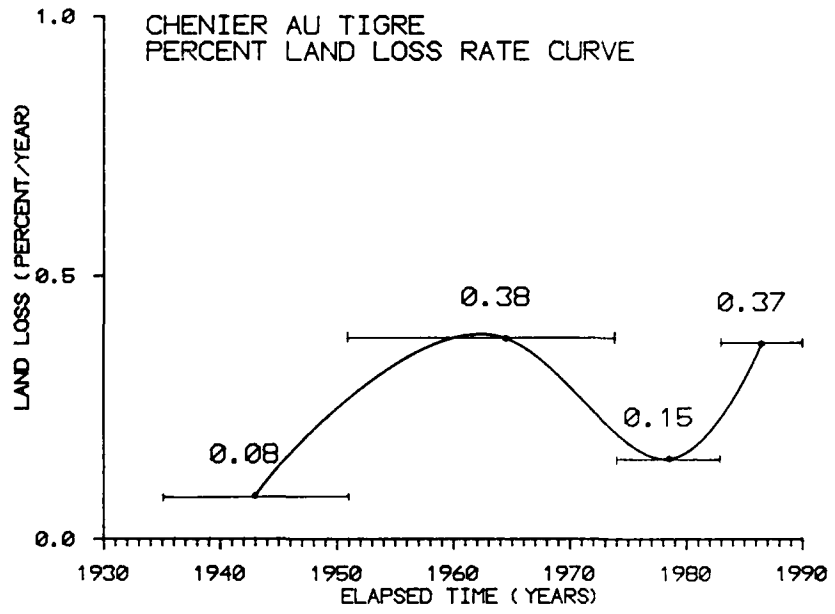

BRETON ISLAND
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
ELAPSED TIME (YEARS)
1.42
1.55
1.26
0.65

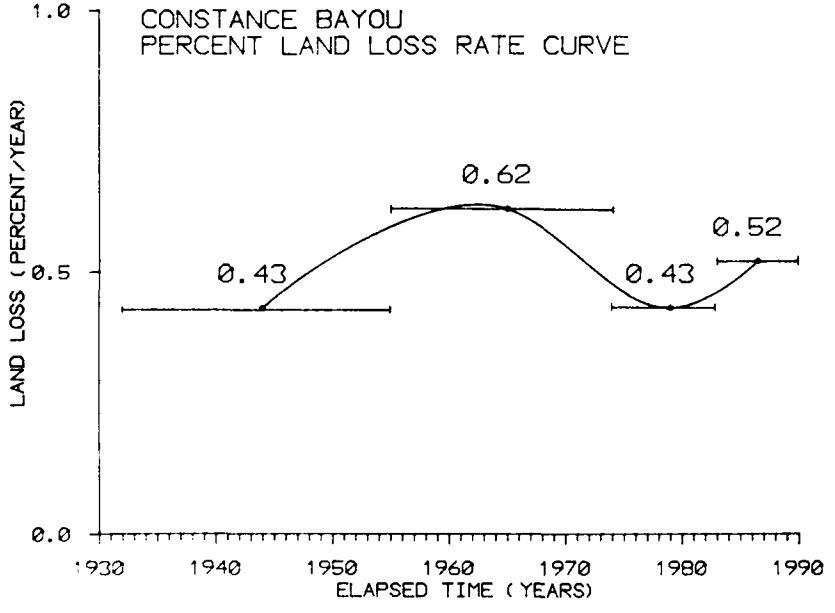

CAILLOU BAY
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
ELAPSED TIME (YEARS)
0.26
0.50
0.59
0.30

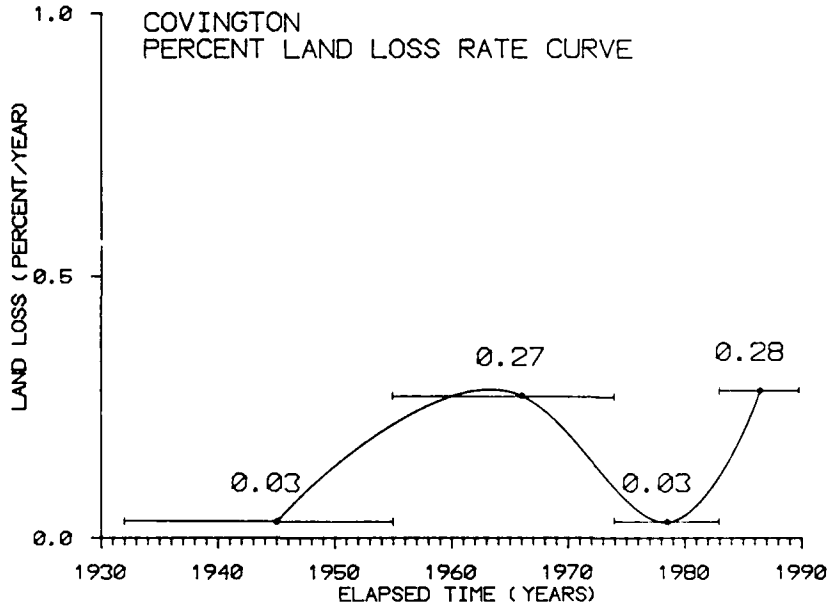

CAMERON
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
ELAPSED TIME (YEARS)
0.05
1.55
0.53
0.23

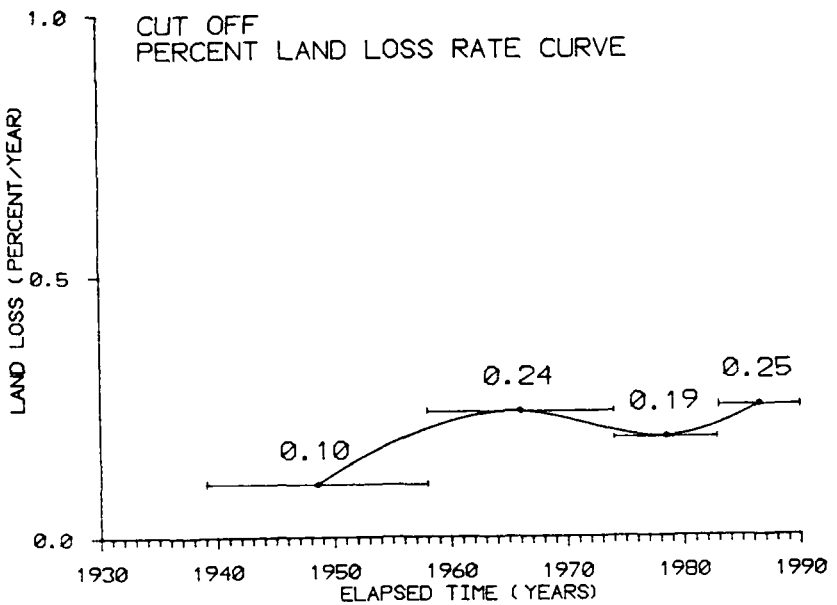

CAT ISLAND
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
ELAPSED TIME (YEARS)
0.61
0.92
1.33
0.96

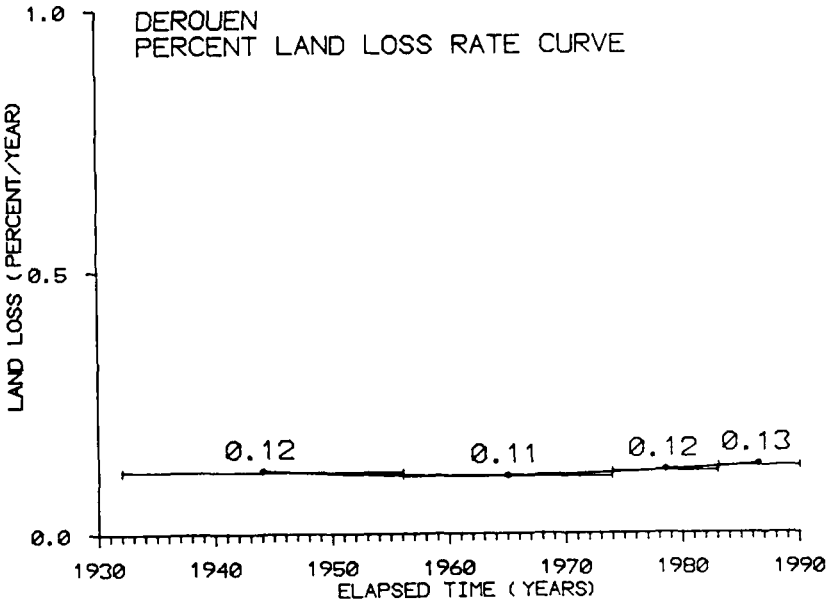

CHEF MENTEUR
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.48
0.46
0.34
0.35
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

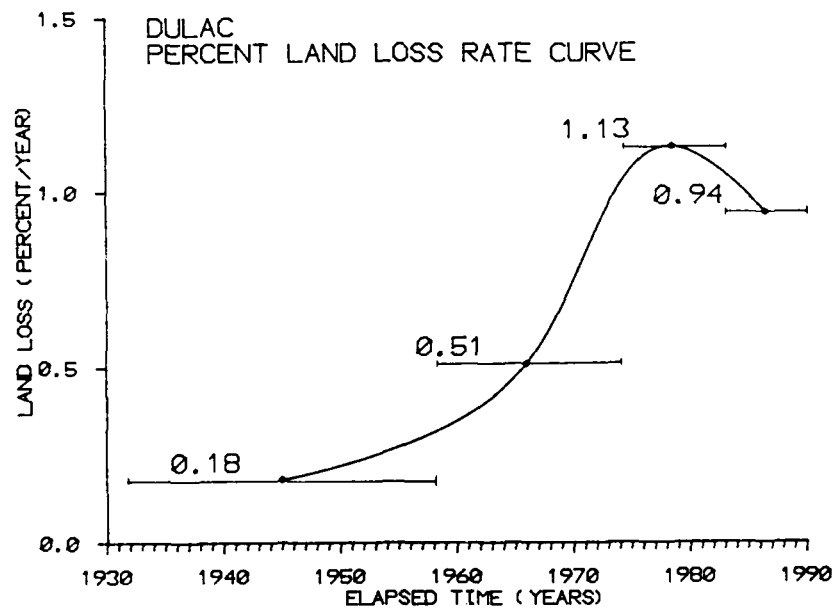

CHENIER AU TIGRE
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.08
0.38
0.15
0.37
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

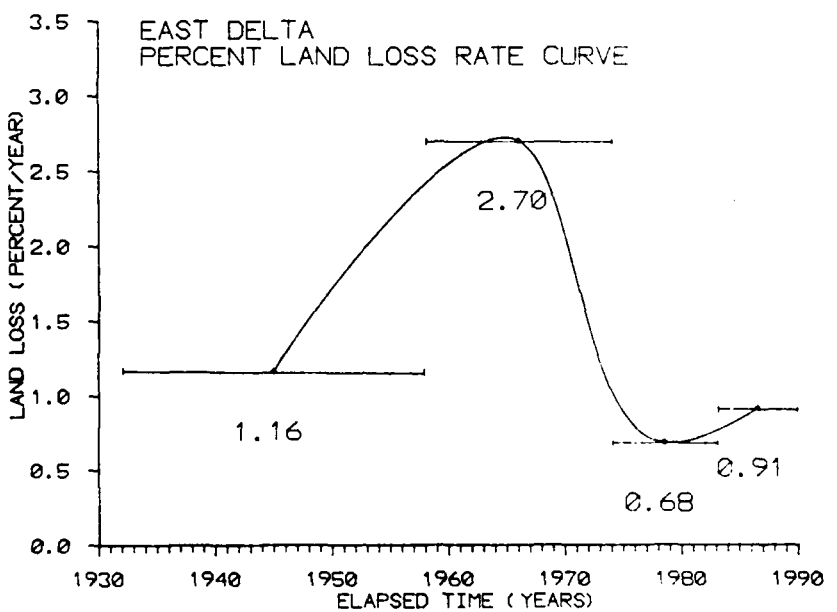

CONSTANCE BAYOU
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.43
0.62
0.43
0.52
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

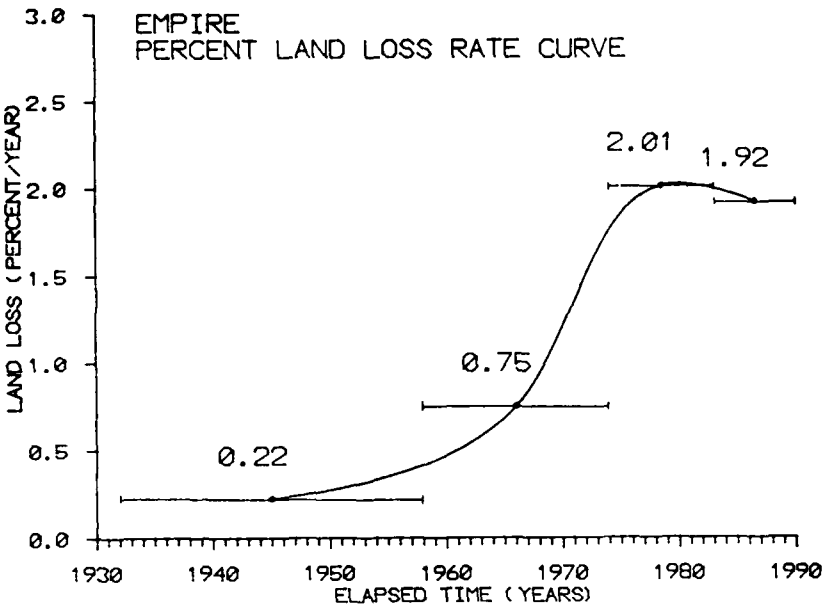

COVINGTON
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.03
0.27
0.03
0.28
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

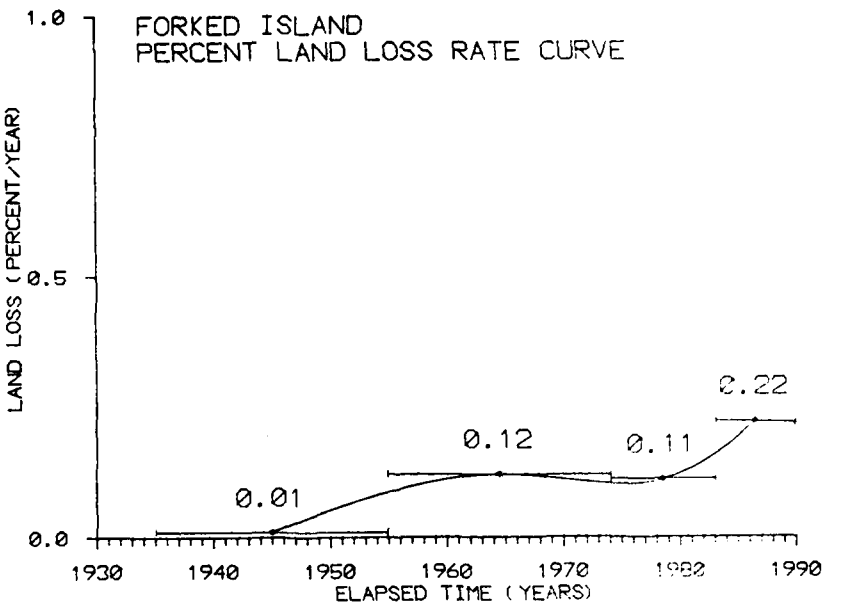

CUT OFF
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.10
0.24
0.19
0.25
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

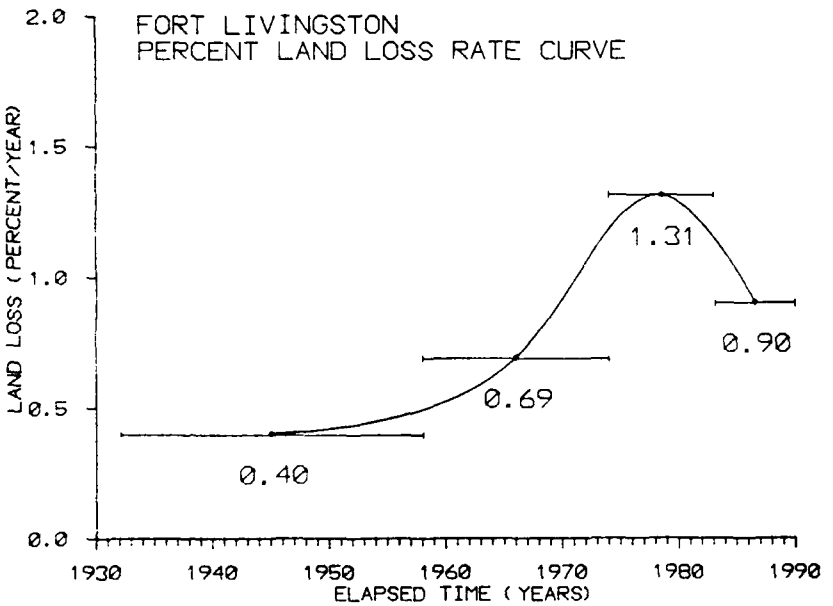

DEROUEN
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.12
0.11
0.12
0.13
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

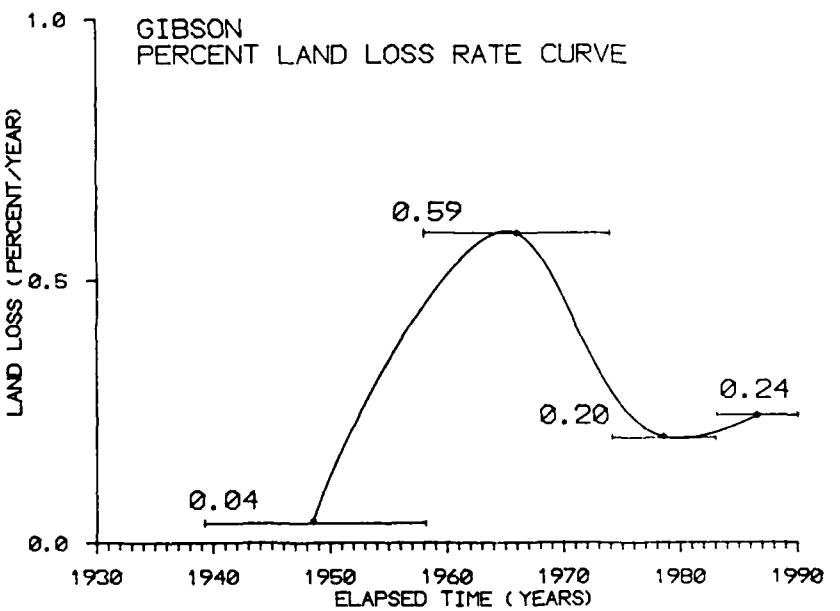

DULAC
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.5
1.0
0.5
0.0
0.18
0.51
1.13
0.94
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

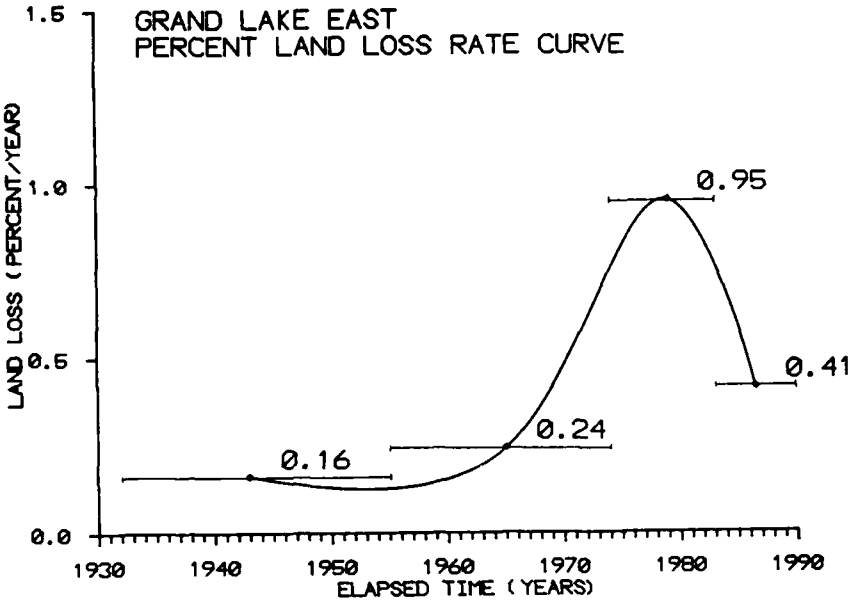

EAST DELTA
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1.16
2.70
0.68
0.91
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

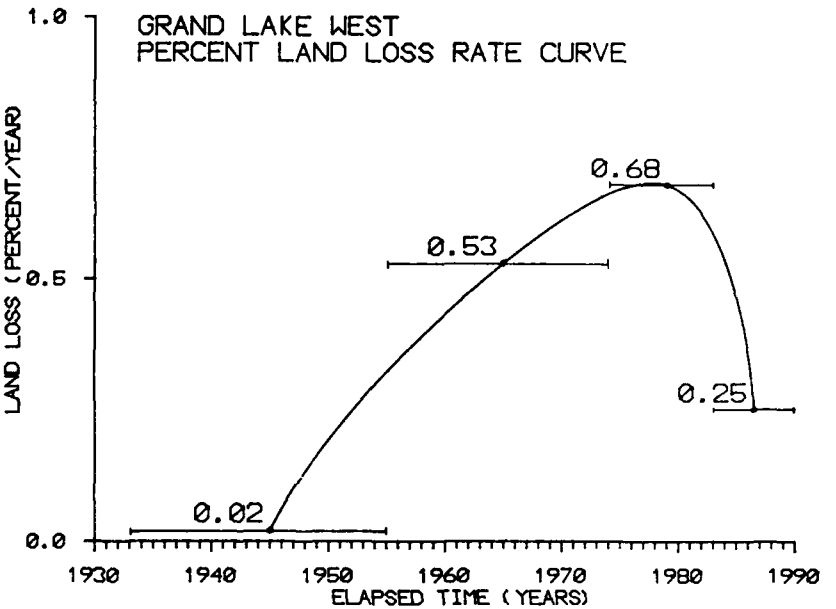

EMPIRE
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2.01
1.92
0.75
0.22
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

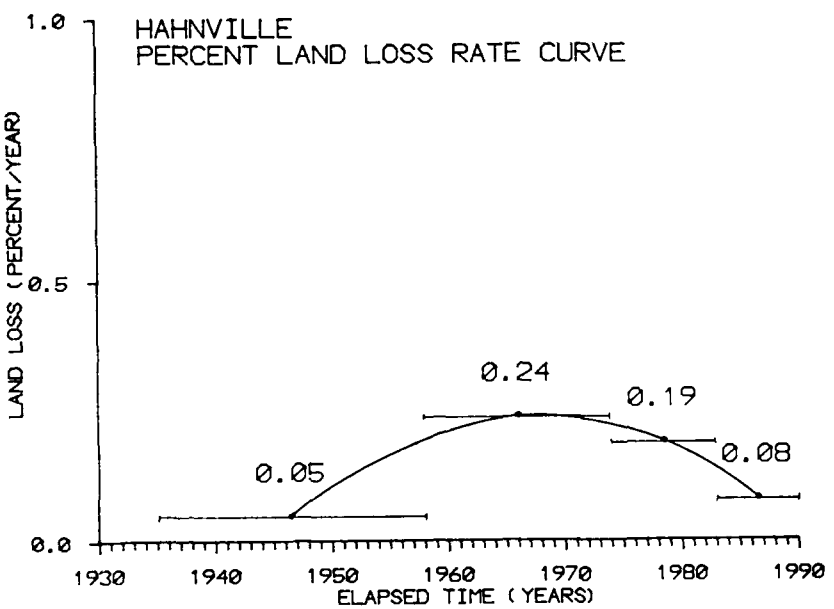

FORKED ISLAND
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.22
0.12
0.11
0.01
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

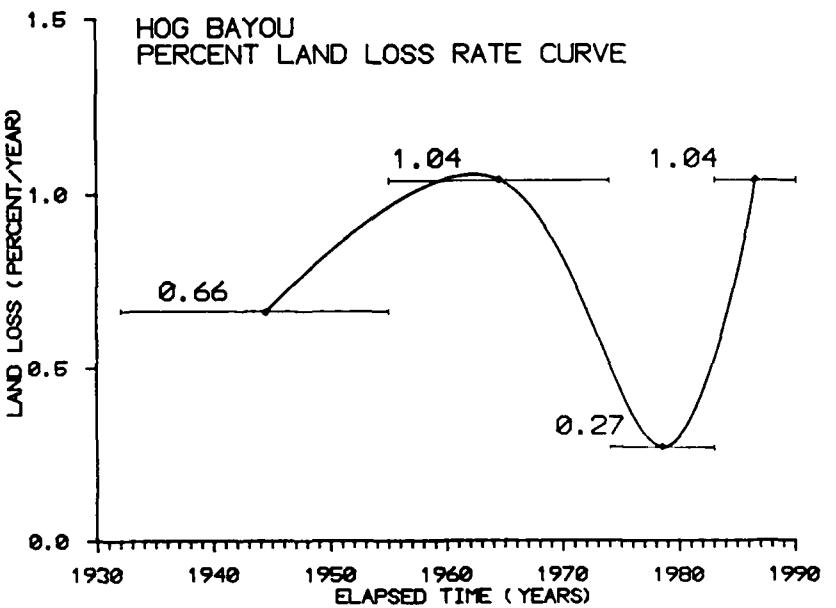

FORT LIVINGSTON
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
2.0
1.5
1.0
0.5
0.0
1.31
0.90
0.69
0.40
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

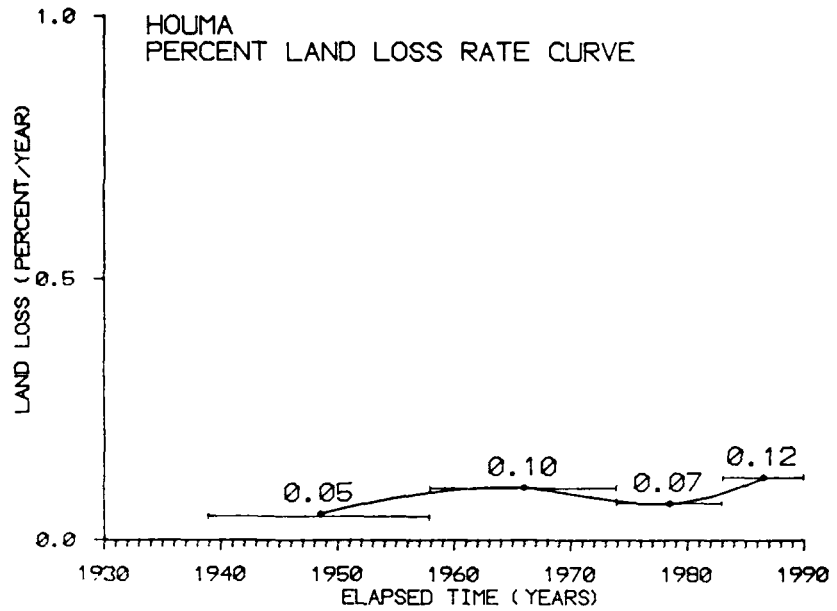

GIBSON
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.59
0.24
0.20
0.04
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

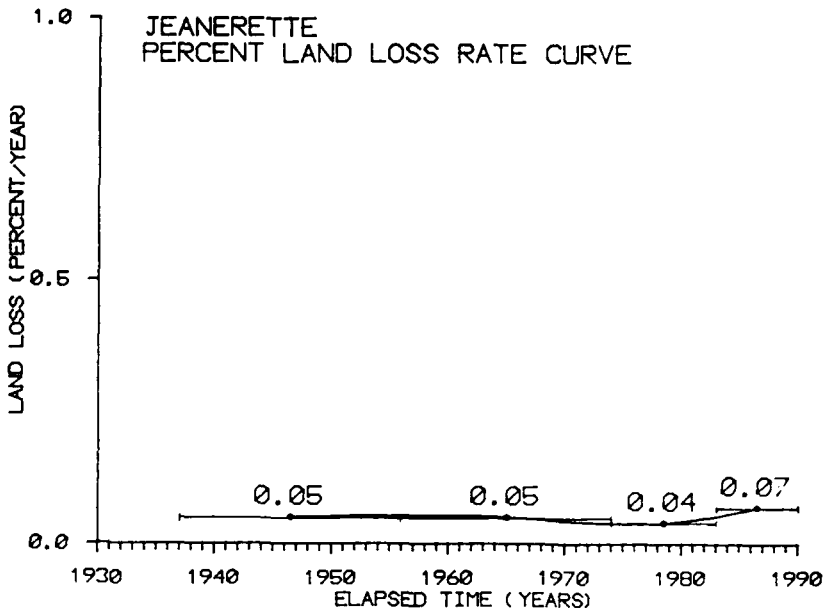

GRAND LAKE EAST
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.5
1.0
0.5
0.0
0.16
0.24
0.95
0.41
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

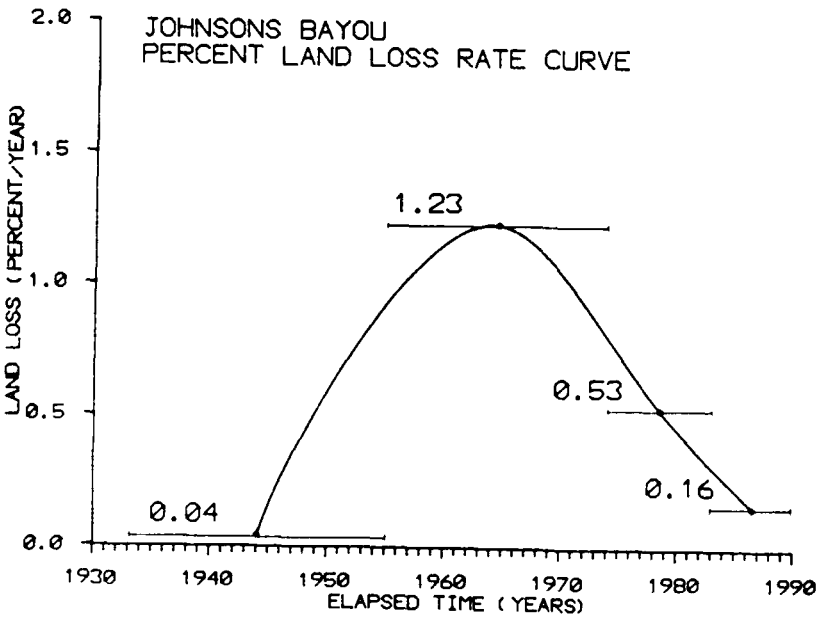

GRAND LAKE WEST
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.02
0.53
0.68
0.25
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

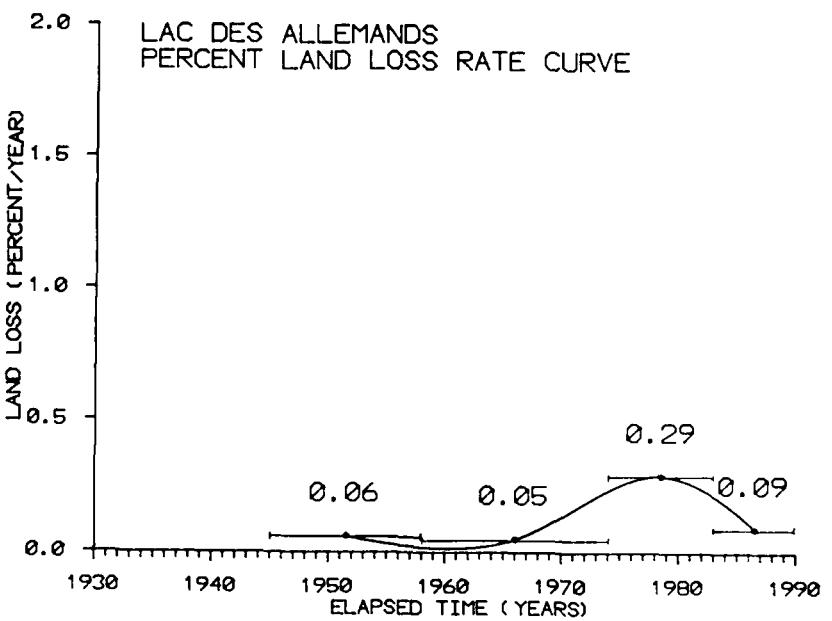

HAHNVILLE
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.05
0.24
0.19
0.08
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

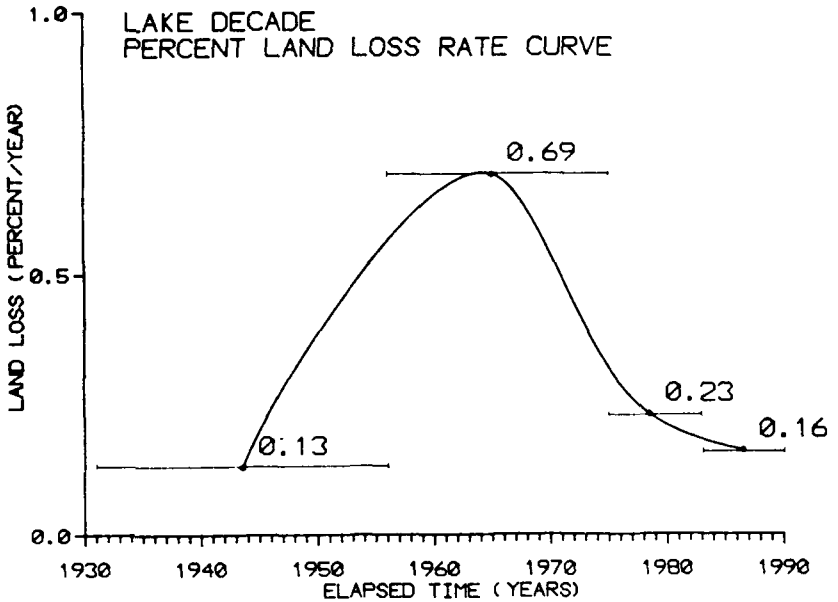

HOG BAYOU
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.5
1.0
0.5
0.0
0.66
1.04
0.27
1.04
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

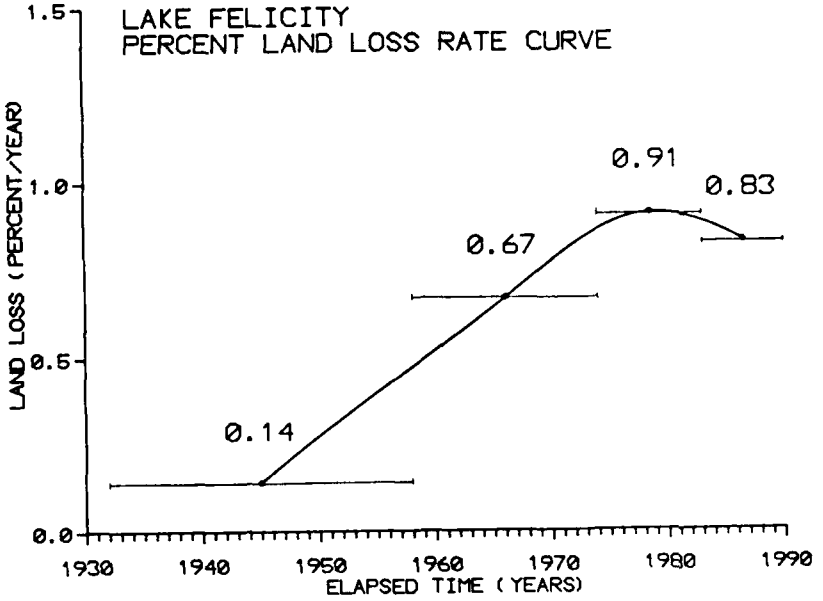

HOUMA
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.05
0.10
0.07
0.12
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

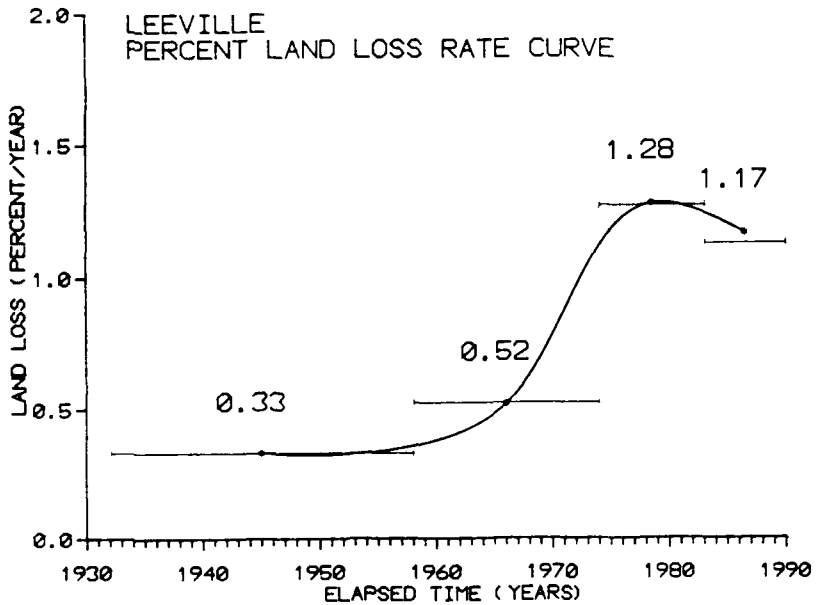

JEANERETTE
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.05
0.05
0.04
0.07
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

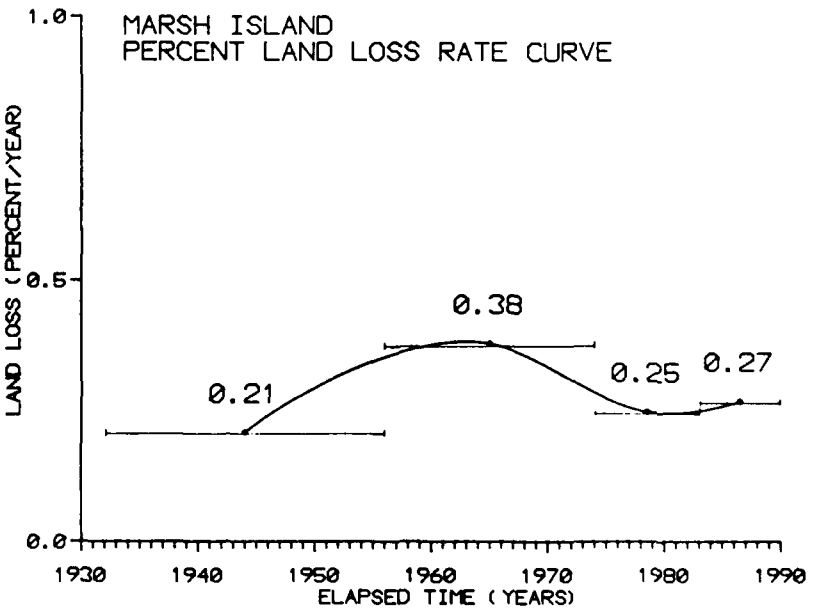

JOHNSONS BAYOU
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
2.0
1.5
1.0
0.5
0.0
1.23
0.53
0.16
0.04
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

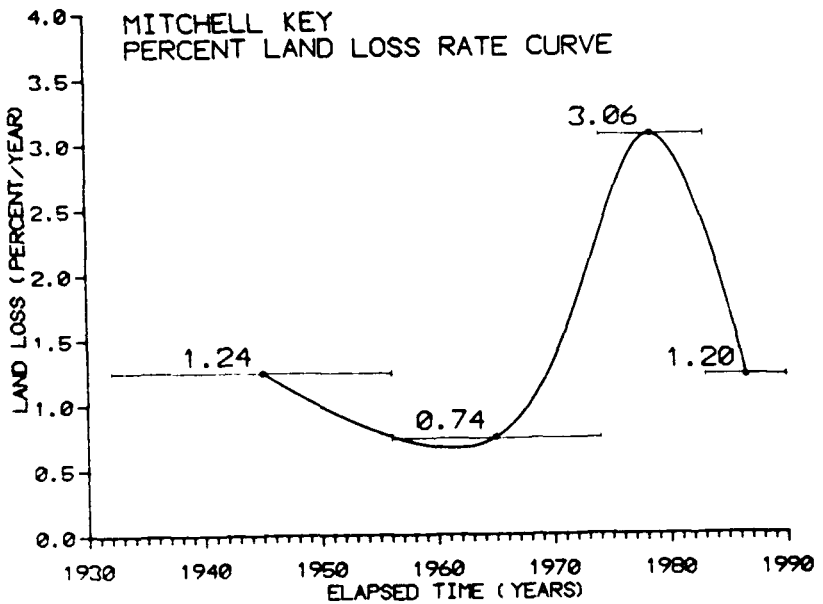

LAC DES ALLEMANDS
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
2.0
1.5
1.0
0.5
0.0
0.29
0.06
0.05
0.09
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

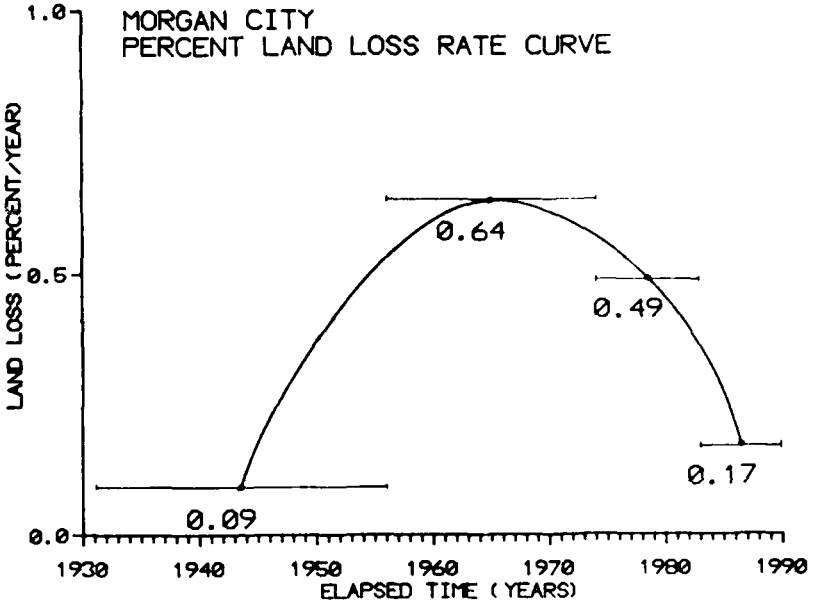

LAKE DECADE
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.69
0.23
0.16
0.13
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

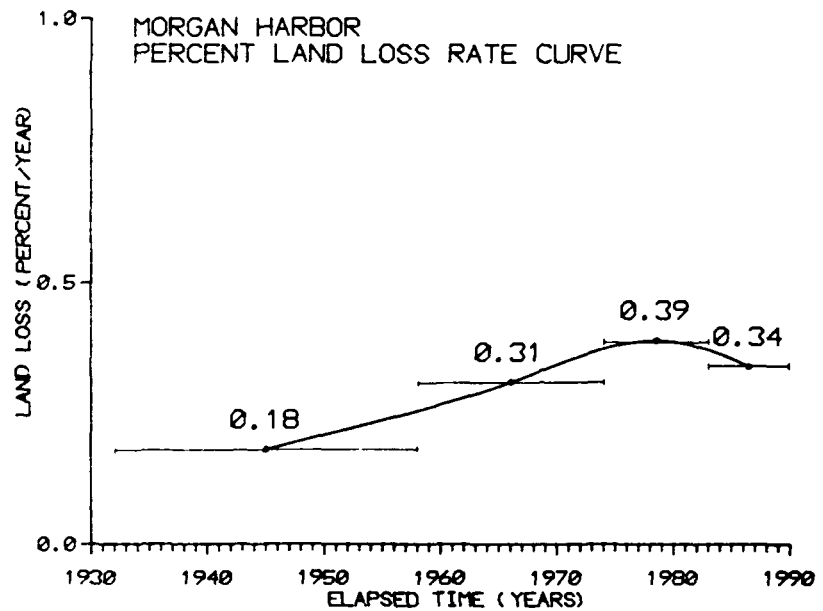

LAKE FELICITY
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.5
1.0
0.5
0.0
0.91
0.83
0.67
0.14
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

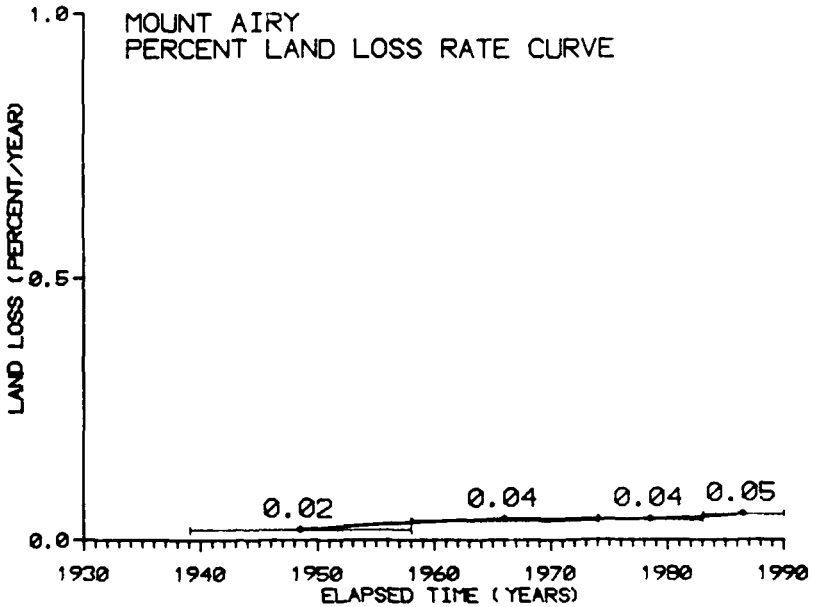

LEEVILLE
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
2.0
1.5
1.0
0.5
0.0
1.28
1.17
0.52
0.33
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

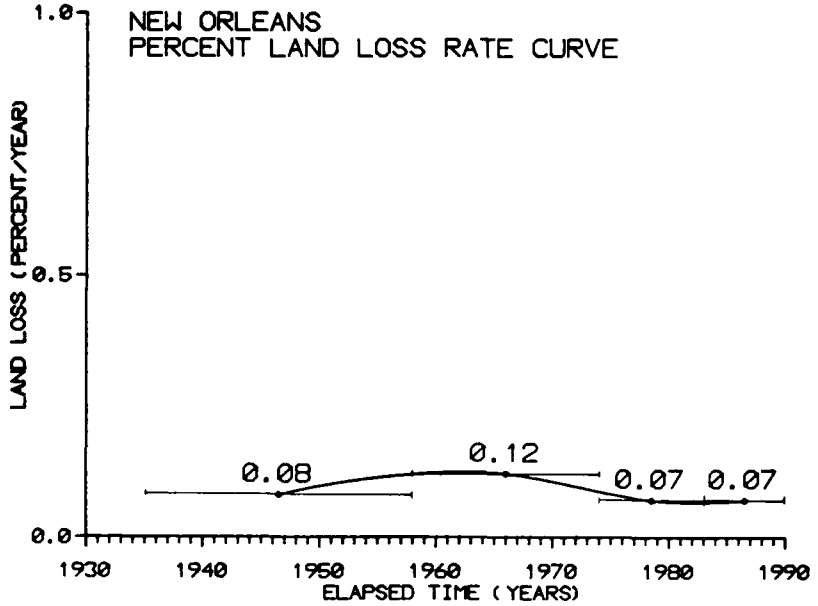

MARSH ISLAND
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.38
0.25
0.27
0.21
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

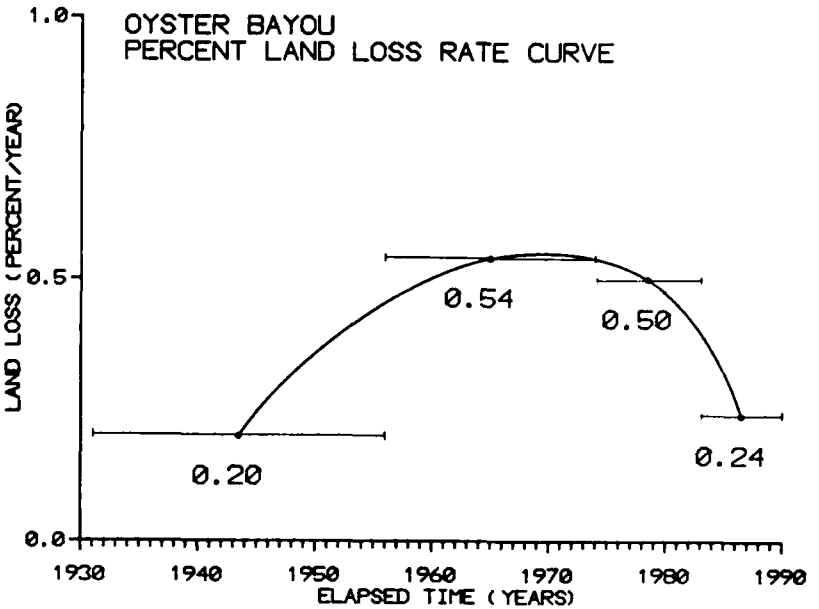

MITCHELL KEY
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1.24
0.74
3.06
1.20
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

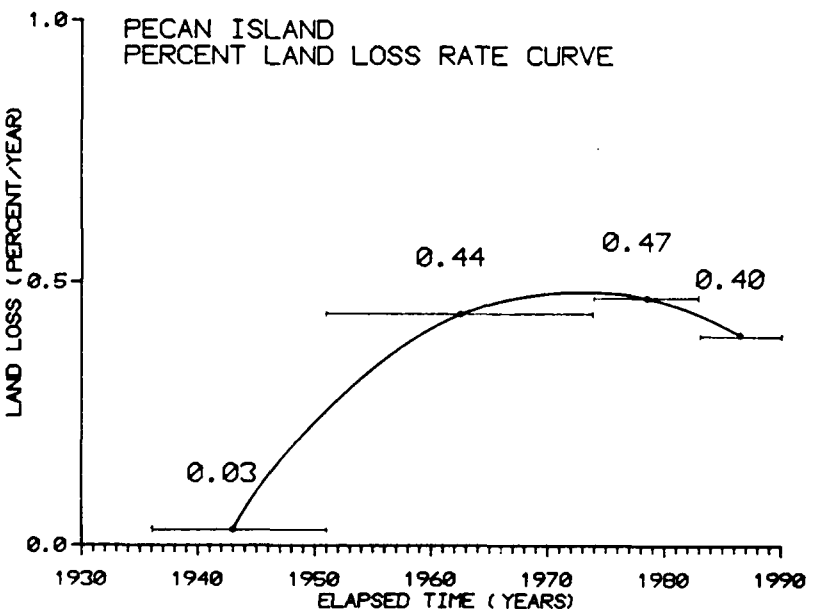

MORGAN CITY
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.09
0.64
0.49
0.17
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

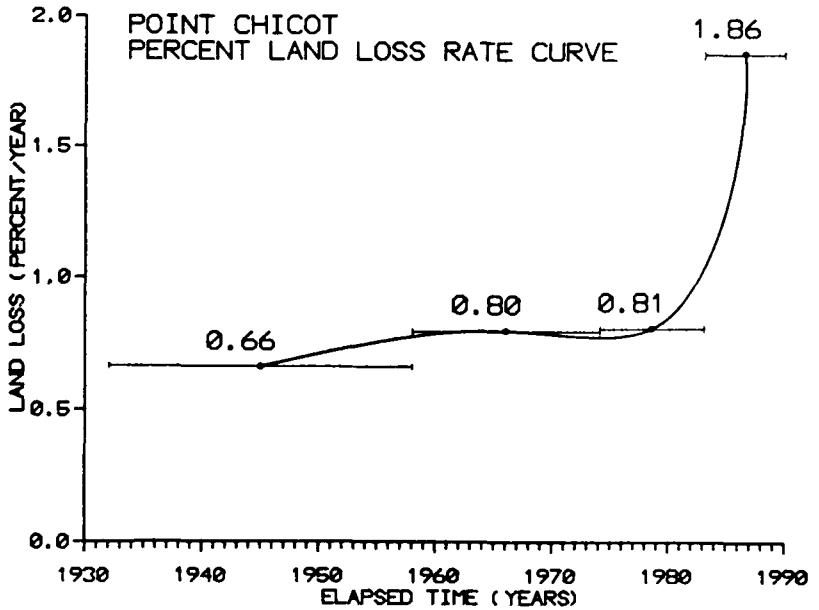

MORGAN HARBOR
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.18
0.31
0.39
0.34
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

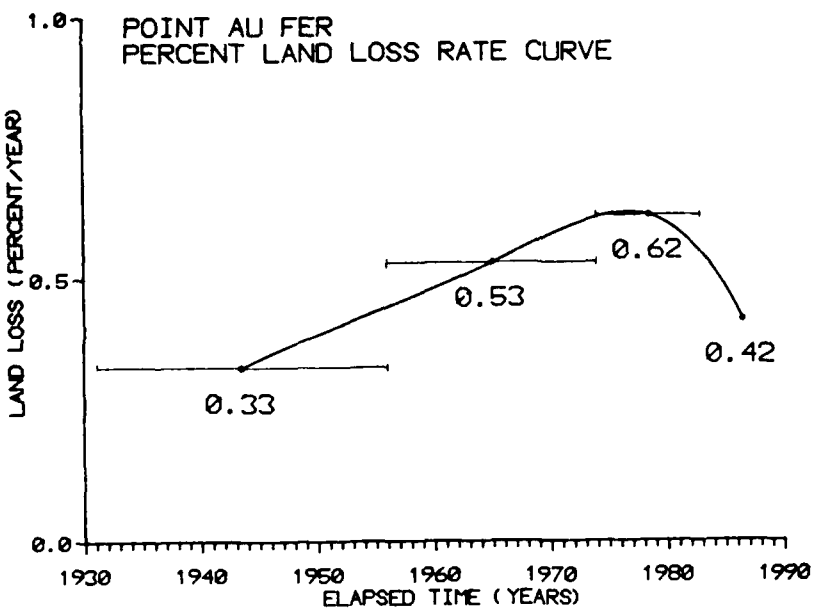

MOUNT AIRY
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.02
0.04
0.04
0.05
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

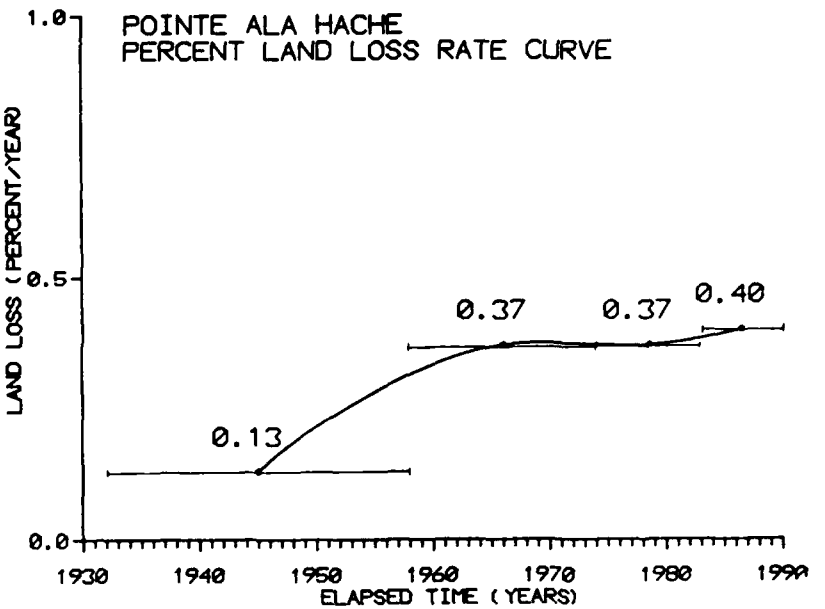

NEW ORLEANS
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.08
0.12
0.07
0.07
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

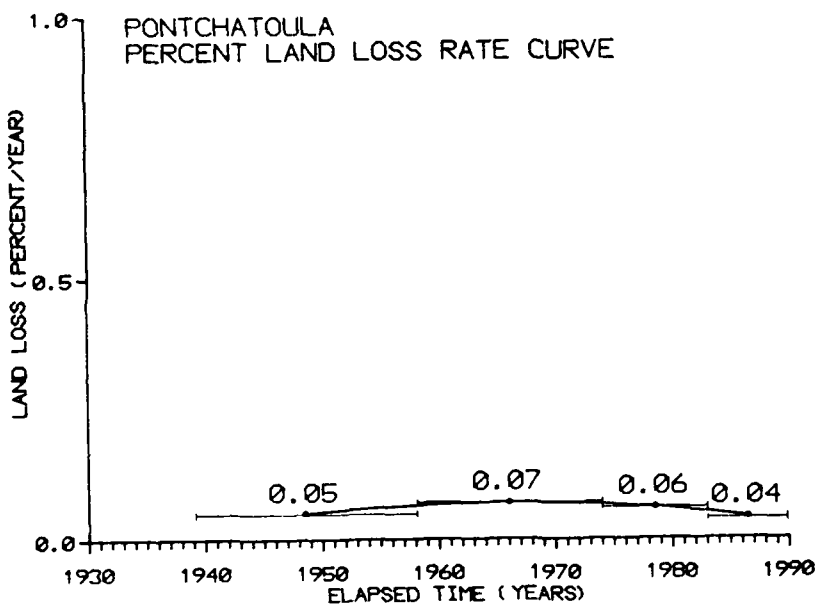

OYSTER BAYOU
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.20
0.54
0.50
0.24
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

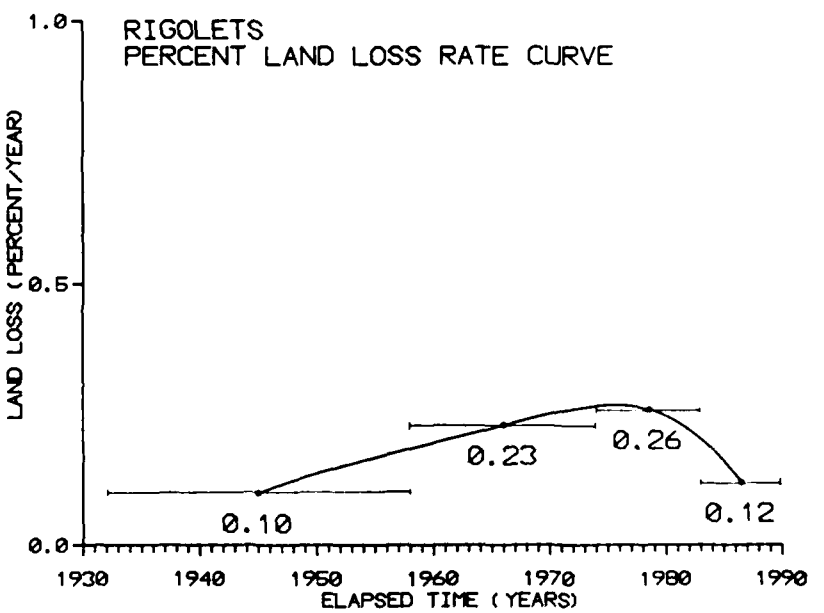

PECAN ISLAND
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.03
0.44
0.47
0.40
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

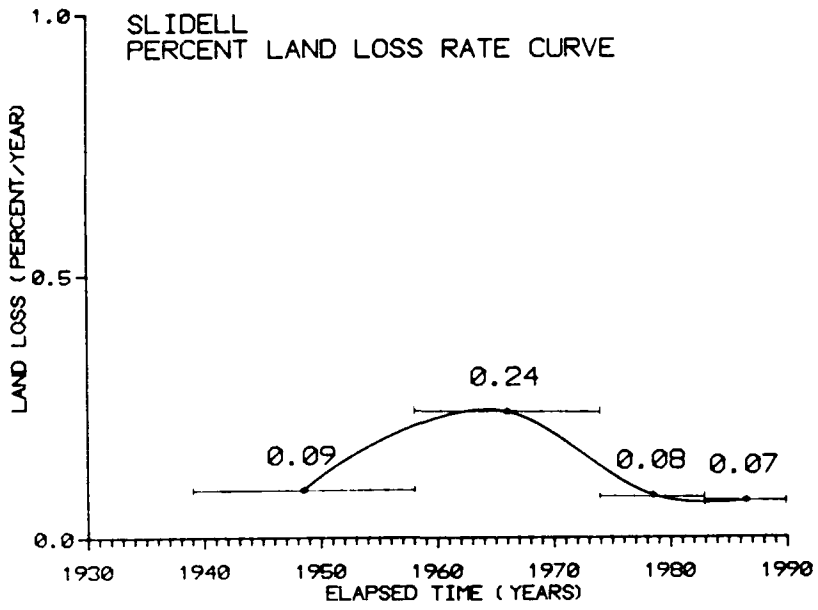

POINT CHICOT
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
2.0
1.5
1.0
0.5
0.0
0.66
0.80
0.81
1.86
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

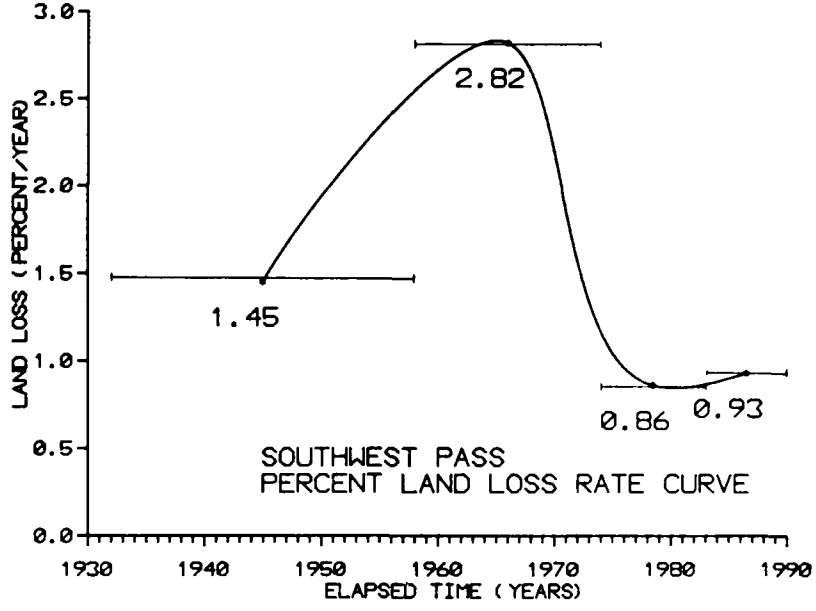

POINT AU FER
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.33
0.53
0.62
0.42
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

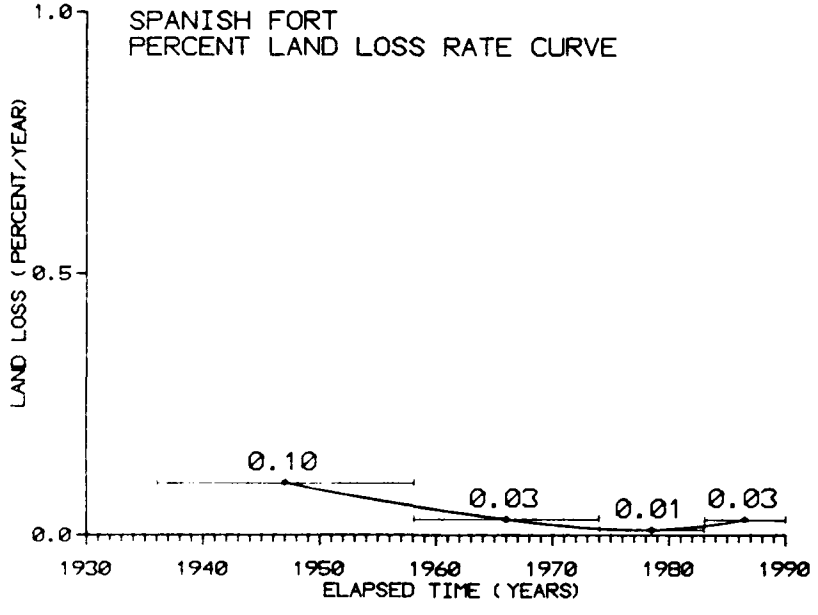

POINTE ALA HACHE
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.13
0.37
0.37
0.40
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

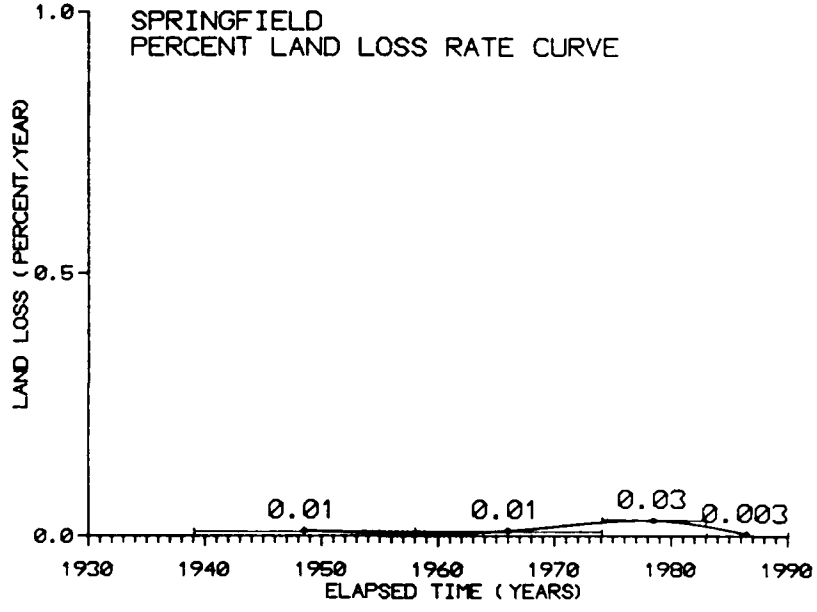

PONTCHATOULA
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.05
0.07
0.06
0.04
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

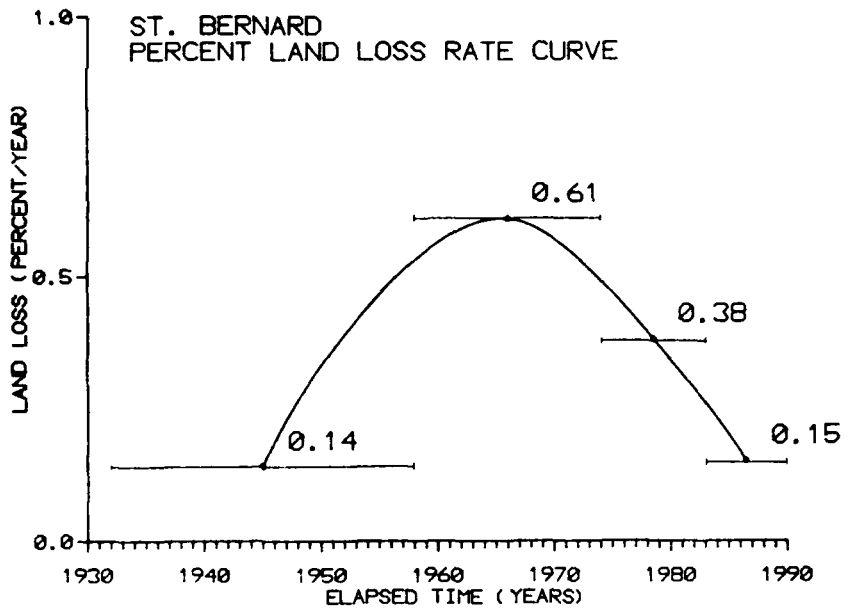

RIGOLETS
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.10
0.23
0.26
0.12
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

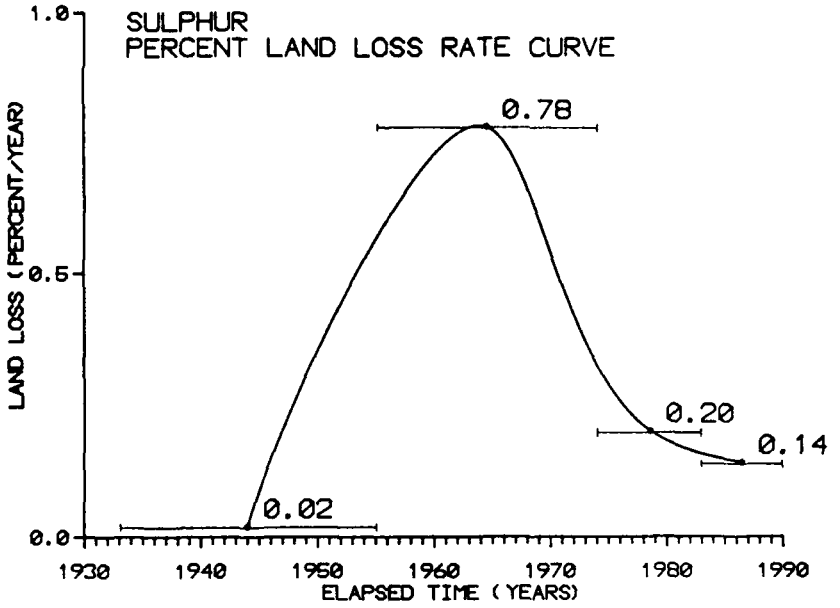

SLIDELL
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.09
0.24
0.08
0.07
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

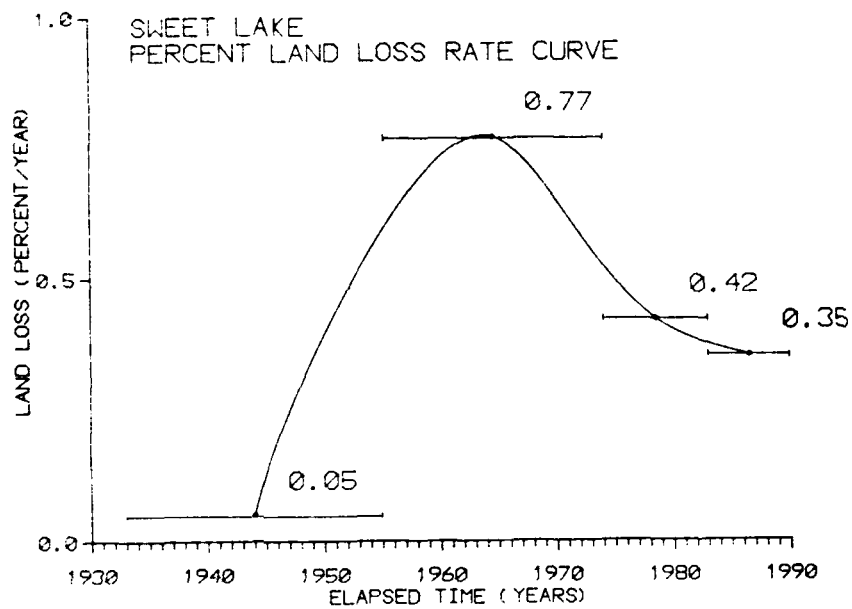

3.0
2.5
2.0
1.5
1.0
0.5
0.0
LAND LOSS (PERCENT/YEAR)
1.45
2.82
0.86
0.93
SOUTHWEST PASS
PERCENT LAND LOSS RATE CURVE
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

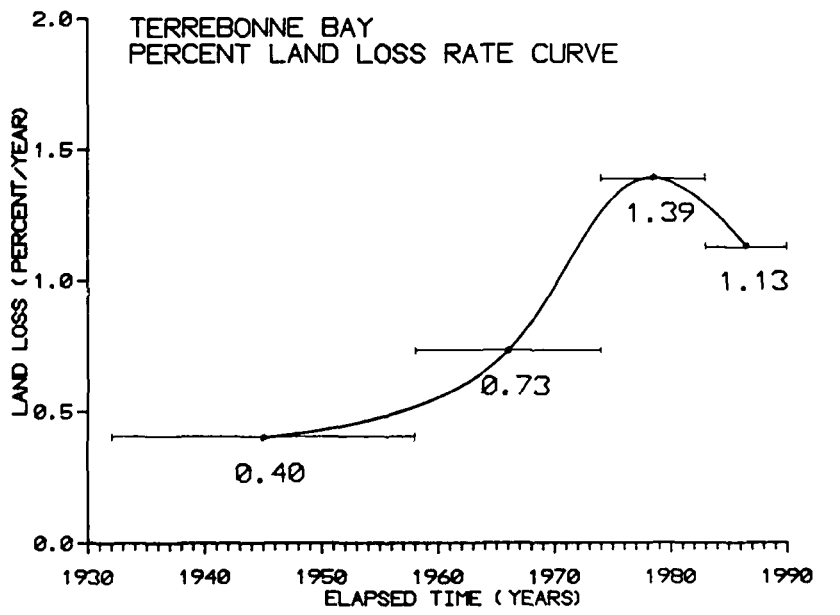

SPANISH FORT
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.10
0.03
0.01
0.03
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

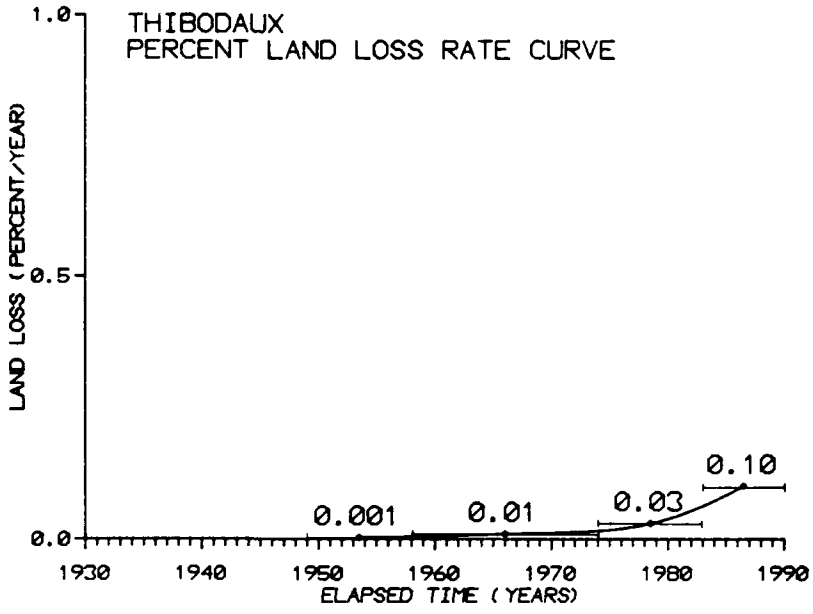

SPRINGFIELD
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.01
0.01
0.03
0.003
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

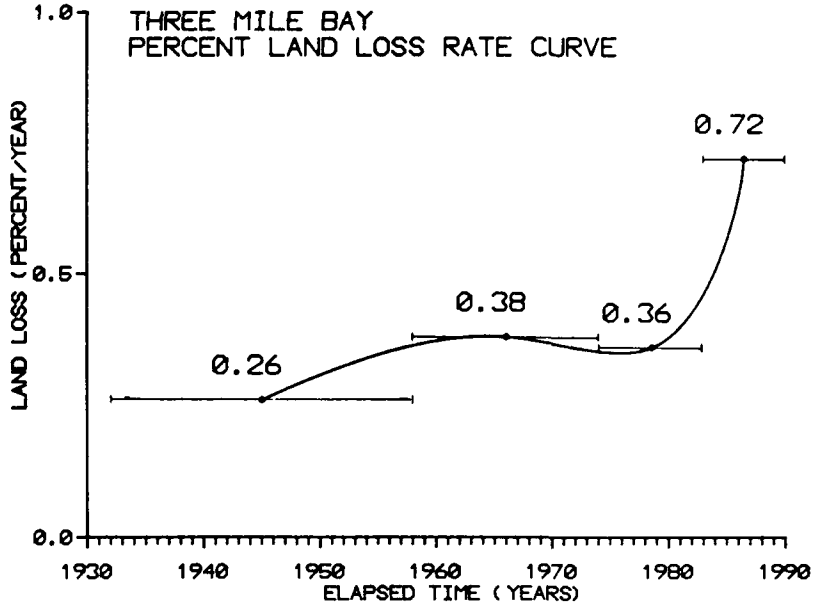

ST. BERNARD
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.61
0.38
0.14
0.15
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

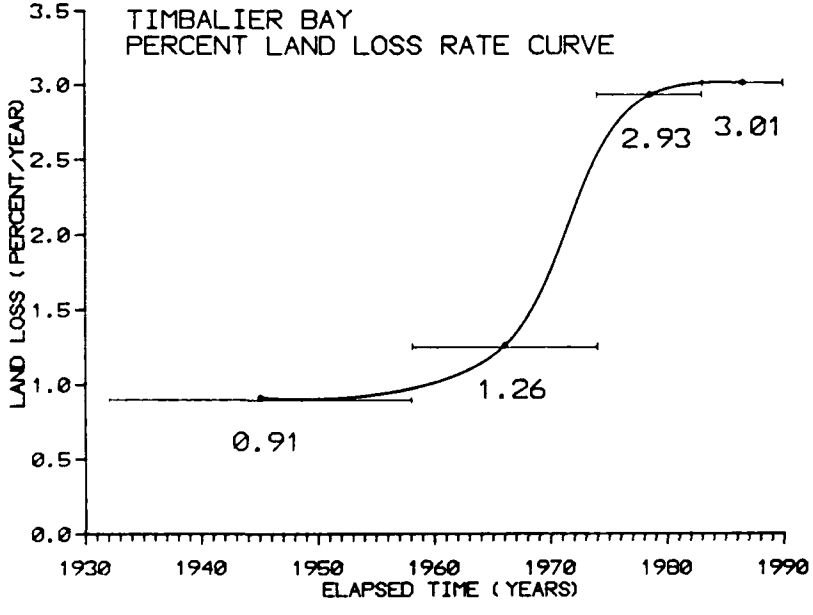

SULPHUR
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.78
0.20
0.14
0.02
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

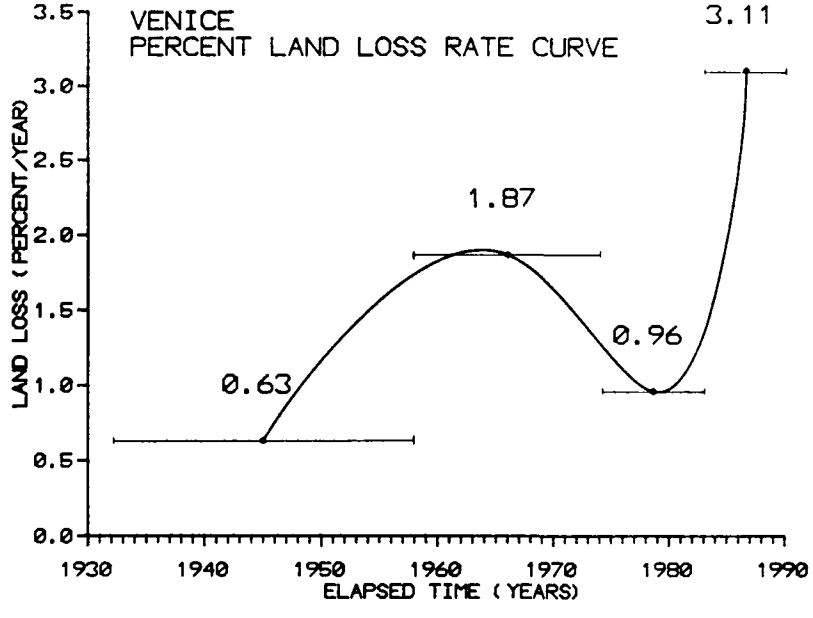

SWEET LAKE
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.77
0.42
0.35
0.05
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

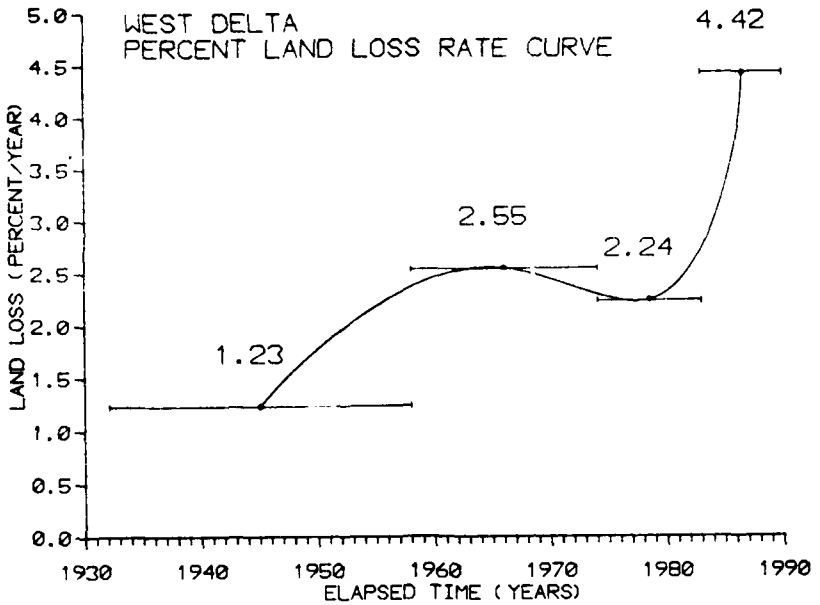

TERREBONNE BAY
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
2.0
1.5
1.0
0.5
0.0
1.39
1.13
0.73
0.40
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

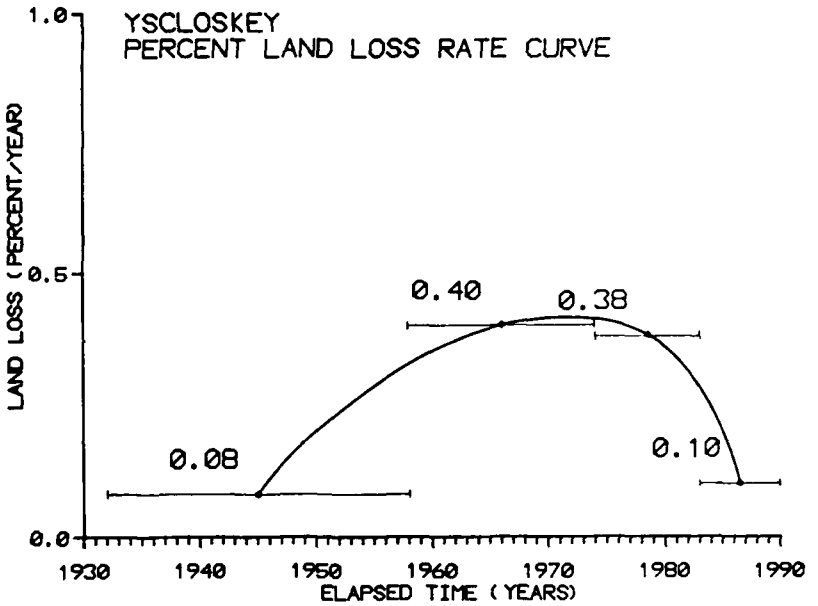

THIBODAUX
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.001
0.01
0.03
0.10
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)


THREE MILE BAY
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
0.26
0.38
0.36
0.72
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)


TIMBALIER BAY
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.91
1.26
2.93
3.01
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)


VENICE
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.63
1.87
0.96
3.11
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)


WEST DELTA
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
ELAPSED TIME (YEARS)
1.23
2.55
2.24
4.42
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1930
1940
1950
1960
1970
1980
1990


YSCLOSKEY
PERCENT LAND LOSS RATE CURVE
LAND LOSS (PERCENT/YEAR)
ELAPSED TIME (YEARS)
0.08
0.40
0.38
0.10
1.0
0.5
0.0
1930
1940
1950
1960
1970
1980
1990